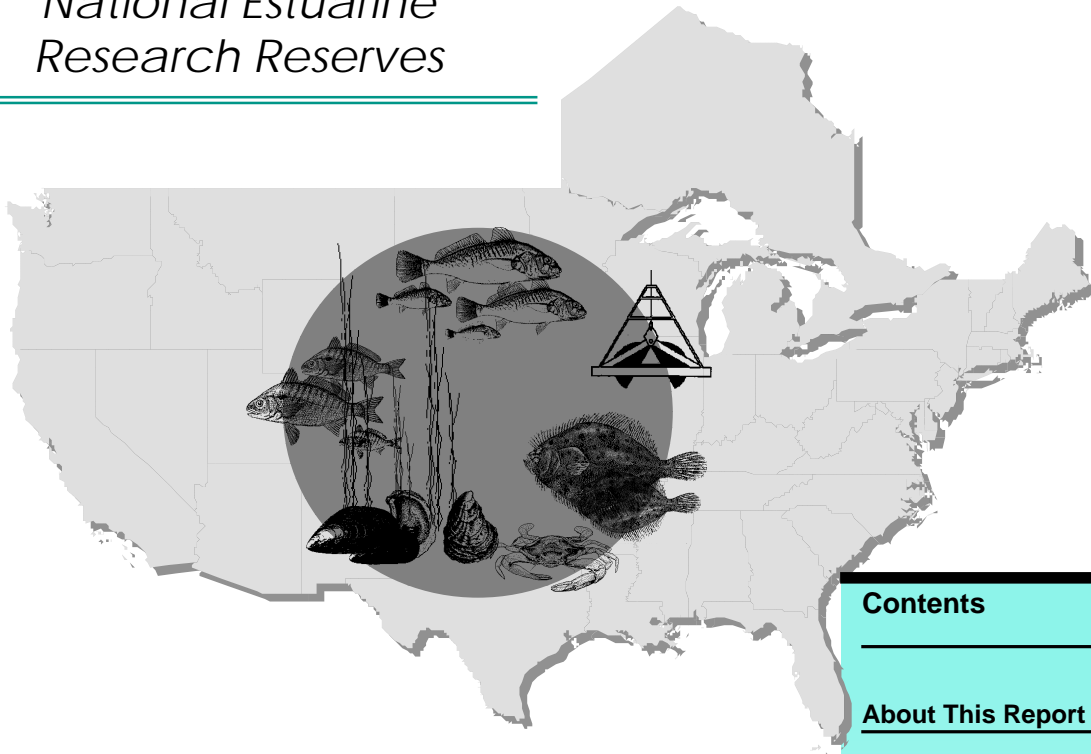


NATIONAL STATUS AND TRENDS PROGRAM

Marine Environmental Quality

Contaminant Levels Measured at NOAA's National Estuarine Research Reserves



Contents

About This Report	1
Summary	1
About the National Status and Trends Program	2
About the National Estuarine Research Reserve System	3
About the Contaminants Monitored	3
Sampling Methods and Site Selection Criteria	4
About the Data	5
Discussion	6
References	7
Data	8
Appendices	25

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
Office of Ocean Resources Conservation and Assessment
Coastal Monitoring and Bioeffects Assessment Division
Silver Spring, Maryland 20910

This Report was Prepared
by
B. William Gottholm
and
Andrew Robertson

Coastal Monitoring and Bioeffects Assessment
Division
Office of Ocean Resources Conservation and
Assessment
National Ocean Service
National Oceanic and Atmospheric Administration
1305 East West Highway
Silver Spring, Maryland 20910

March 1996

About This Report

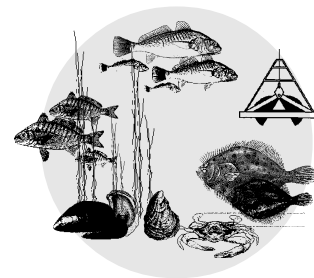
Inputs of toxic chemicals provide one of the major types of anthropogenic stress threatening our nation's coastal and estuarine waters. To assess this threat, the National Oceanic and Atmospheric Administration's (NOAA) National Status and Trends (NS&T) Program monitors the concentrations of more than 70 toxic chemicals in sediments and in the livers of benthic fish (Benthic Surveillance Project) and on the whole soft-parts of mussels and oysters (Mussel Watch Project) at over 300 sites around the U.S. Sixteen of these sites are in or close to one of the 22 designated areas that comprise NOAA's National Estuarine Research Reserve System (NERRS). The data collected at these 16 sites are part of the NS&T Program's Mussel Watch Project in which measurements of bioaccumulation of toxic chemicals in bivalves (mussels and oysters) are used to assess ambient contaminant condi-

tions.

This report presents a summary of the concentrations of contaminants in bivalves at these 16 sites and compares these results to the levels found in bivalves at all NS&T Mussel Watch sites nationwide. Additionally, levels in sediments from these sites are presented and compared to the sediment concentrations found nationwide at all NS&T sites. This is intended to provide assistance to Reserve managers in evaluating the toxic contaminant conditions in their area and to place these conditions in perspective to those found throughout the nation.

Summary

The levels for 8 metallic elements and 4 categories of the most problematic organic chemicals have been examined in this report. In general the levels in or near the Reserves are close to or below the national mean for these chemicals at all Mussel Watch sites. However, there are exceptions where high values relative to the national means are found. For bivalve tissue, contaminant concentrations of arsenic are relatively high in or near the Reserves along the southeast coast; cadmium, copper, nickel, lead and zinc are high near the Blackbird Creek component of the Delaware Reserve; copper is high in the Narragansett Bay Reserve; and nickel is high in the Elkhorn Slough Reserve. Total PAH's are high near the North Carolina



Reserve; total DDT's are high in or near the Delaware, Tijuana River, and Elkhorn Slough Reserves, and total PCB's in mussel tissue are high near the Waquoit Bay Reserve.

Results from the NS&T sediment data show that for sediments, concentrations of arsenic are also relatively high in or near the Reserves along the southeast coast; cadmium and nickel are high near the South Slough Reserve; for most sites, copper is near the national mean with sites near the South Slough, North Inlet-Winyah Bay, and Jobos Bay Reserves above the mean; nickel is high near the Blackbird Creek component of the Delaware Reserve as well as the North Inlet-Winyah Bay and South Slough Reserves; zinc is high at the Blackbird Creek component of the Delaware Reserve, while the North Inlet-Winyah Bay Reserve shows high concentrations of both zinc and selenium; mercury is high at the Jobos Bay Reserve; lead concentrations do not exceed the NS&T calculated high but most are at or exceed the mean. Total Chlordane concentrations are high in or near the Waquoit Bay, North Carolina, and North Inlet-Winyah Bay Reserves, and total PAH's are high near the North Carolina Reserve.

About the National Status and Trends Program

☛ In response to the need for information assessing the effects of human activities on environmental quality in coastal and estuarine areas, and the need to develop management strategies to deal with these conditions, the Coastal Monitoring and Bioeffects Assessment Division (CMBAD) of the National Oceanic and Atmospheric Administration (NOAA) initiated, in 1984, the National Status and Trends (NS&T) Program. The purpose of this program is to determine the current status and to detect trends in the environmental quality of our nation's estuarine and coastal waters. Because of concern over inputs of contaminants to U.S. coastal waters, it

was decided to focus the program initially on these substances and their effects.

☛ As part of its nationwide monitoring, the Mussel Watch Project within the NS&T Program monitors the levels of more than 70 contaminants and certain associated effects in biota and sediments at over 240 sites (Figure 1). It provides data for making spatial and temporal comparisons of contaminant levels to determine which regions around our coasts are of greatest concern regarding existing or developing potential for environmental degradation. Distributed along the coastal and estuarine shores of the U.S., these sites are on average 20 kilometers apart in estuaries and embayments and 100 kilometers apart along the open coastlines. These sites were selected in order to provide samples that are representative

of a large area. Known waste discharge points and other focal points of potential contamination were avoided. Mussels and oysters were chosen for sampling because they are sessile (and characteristic of a particular location), hardy (providing ample samples on an annual basis), reliable accumulators of contaminants, and are easily obtained.

☛ Sampling and analyses for the NS&T Program are performed using well documented methods and techniques, so that a known level of confidence can be assigned to all data (Cantillo and Lauenstein, 1993). Analytical procedures adhere to the standards of a rigorous Quality Assurance Project, established for all laboratories participating in the NS&T Program (Lauenstein and Cantillo, 1993).

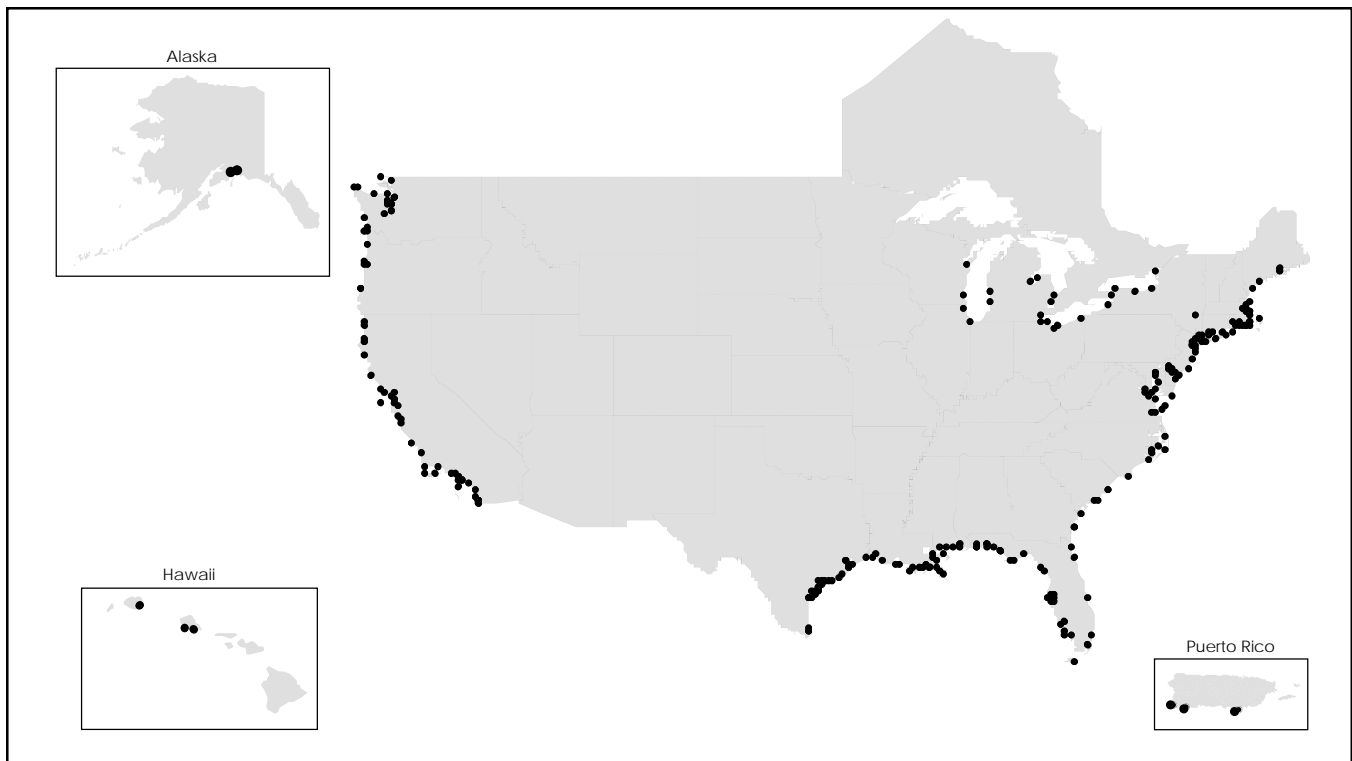


Figure 1. NS&T Mussel Watch Project monitoring sites.

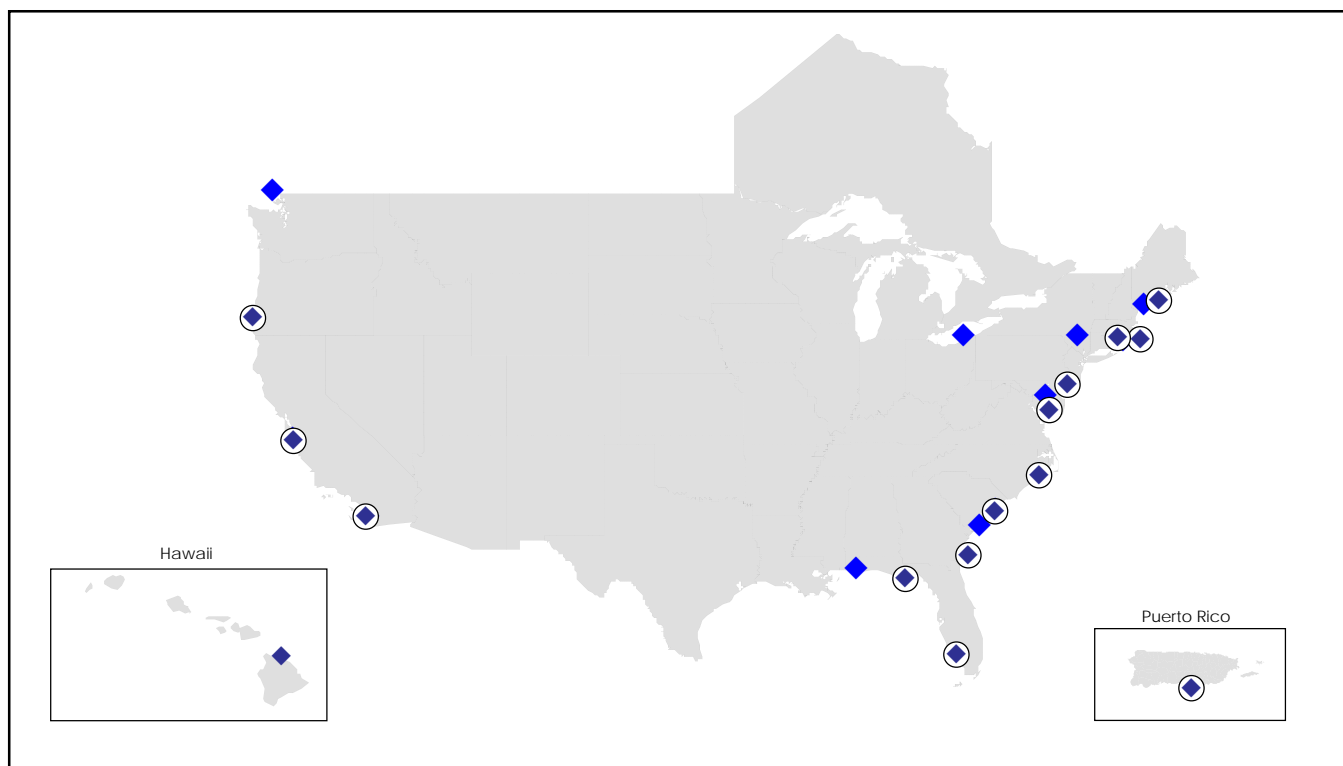


Figure 2. *The National Estuarine Research Reserve System [◆ Reserves with NS&T sites].*

About the National Estuarine Research Reserve System

☛ The National Estuarine Research Reserve System (NERRS) was established by the United States Congress as part of the Coastal Zone Management Act of 1972. NOAA's Sanctuaries and Reserves Division (SRD) is responsible for oversight of the establishment and management, through Federal-State cooperation, of this national system of twenty-two areas.

☛ Because of their beauty and abundant resources, estuaries are frequently targeted for residential, recreational and commercial development. Such human activity often threatens the vulnerable ecosystems found in estuaries. The NERRS

is designed to identify and protect a network of such estuaries that are representative of the wide range of coastal habitats found in the various regions and estuarine types of the United States (Figure 2).

☛ The goals of the program are to ensure a stable environment for research through long-term protection of estuarine reserve resources; to address coastal management issues identified as significant through coordinated estuarine research within the System; to enhance public awareness and understanding of the estuarine environment and provide suitable opportunities for public education and interpretation; to promote Federal, state, public, and private use of one or more of the reserves within the System when such entities conduct estuarine research; and to conduct and coordinate

estuarine research within the System, gathering and making available information necessary for improved understanding and management of estuarine areas.

☛ It is important to note that the reserves are owned and managed by the individual states, with SRD providing management guidelines, financial and technical assistance, national program definition, and support for research, monitoring and educational activities.

About the Contaminants Monitored

☛ The elements and compounds measured in the NS&T Mussel Watch Project are shown in Table 1. With the exceptions of aluminum, iron,

silicon and manganese, the elements in Table 1 are all possible contaminants in the sense that their concentrations in the environment have been altered by human activities (Nriagu, 1989). The mere existence of the chlorinated organic compounds and butyltins indicates human activity. Polycyclic aromatic hydrocarbons (PAHs) are similar to metals in the sense that they occur naturally. They are found in fossil fuels such as coal and oil and are produced during the combustion of organic matter. Their environmental presence is also attributable to humans because they are released in the use and transportation of petroleum products and from a multitude of other human activities, such as burning coal and wood and incinerating waste (O'Connor, 1996).

Sampling Methods and Site Selection Criteria

The primary species of mollusks monitored are: the blue mussel, *Mytilus edulis*, at sites from Maine to Delaware Bay, the American oyster, *Crassostrea virginica*, from Delaware Bay south through the Gulf of Mexico, the mussels, *M. edulis* and *M. californicus*, on the West Coast, the zebra mussels, *Dreissena polymorpha* and *D. bugensis*, at sites in the Great Lakes, the Hawaiian oyster, *Ostrea sandvicensis* in Hawaii, and the mangrove oyster *Crassostrea rhizophorae* in Puerto Rico.

DDT and its metabolites	Polycyclic aromatic hydrocarbons	Major elements
2,4'-DDD 4,4'-DDD 2,4'-DDE 4,4'-DDE 2,4'-DDT 4,4'-DDT	2-ring Biphenyl Naphthalene 1-Methylnaphthalene 2-Methylnaphthalene 2, 6-Dimethylnaphthalene 1,6,7-Trimethylnaphthalene	aluminum iron manganese silicon
Tetra, tri-, di-, and monobutyltins	3-ring	Trace elements
	Fluorene Phenanthrene 1-Methylphenanthrene Anthracene Acenaphthene Acenaphthylene	antimony arsenic cadmium chromium copper lead mercury nickel selenium silver tin zinc
Chlorinated pesticides other than DDT	4-ring	
Aldrin <i>cis</i> -Chlordane <i>trans</i> -Nonachlor Dieldrin Heptachlor Heptachlor epoxide Hexachlorobenzene Lindane (gamma-HCH) Mirex	Fluoranthene Pyrene Benz[<i>a</i>]anthracene Chrysene	
Polychlorinated biphenyls	5-ring	
PCB congeners 8, 18, 28, 44, 52, 66, 77, 101, 105, 118, 126, 128, 138, 153, 179, 180, 187, 195, 206, 209	Benz[<i>a</i>]pyrene Benz[<i>e</i>]pyrene Perylene Dibenz[<i>ah</i>]anthracene Benz[<i>b</i>]fluoranthene Benz[<i>k</i>]fluoranthene	
Toxaphene at some sites	6-ring	
	Benz[<i>ghi</i>]perylene Indeno[1,2,3- <i>cd</i>]pyrene	
	Related parameters	
	Grain Size Total Organic Carbon (TOC) <i>Clostridium perfringens</i> spores	

Table 1. Chemicals measured.

For the first years of the program (1986-1991), the objective in sampling bivalves was to obtain three discrete composite samples. In general, at each site, a bivalve sample consisted of 20 to 30 mollusks, depending on size and species. In 1992, the number of specimens collected at each station was reduced to that necessary for one composite sample per site. Field sampling along the East and West Coasts was accomplished using a variety of techniques such as a bivalve dredge, tongs, pitch fork, and, at some shoreline sites, intertidal bivalve populations were collected by hand. After collection, bivalves were separated and scrubbed with a nylon or natural fiber brush to remove adhering detritus. For

Gulf Coast sampling, oysters were collected with tongs, dredge and, where possible, by hand. In some areas, field collection techniques were constrained by sampling permits and prohibited use of equipment.

NS&T sediment results included in this report are based on the sampling of three stations per site, with each station providing separate sample material for organic and trace element analyses and for sediment characteristics such as grain size and total organic carbon (TOC). Composite samples were made from surface sediment in those three grabs.

A complete overview and summary of the sampling and analytical methods of the

NS&T Program are described in Lauenstein and Cantillo, 1993.

☛ The criterion for the NS&T sites selected for inclusion in this report was that they be within the boundaries of a National Estuarine Research Reserve or be located nearby (no more than 5 miles). Table 2 lists the Reserves where NS&T sites meet this criterion. It should be noted that NS&T samples were collected from within the Hudson River reserve's network of four sites. However, results from the sample analysis for this site are not available at this time.

About the Data

☛ The graphs on the following pages show the geometric mean concentrations of contaminants for bivalves and sediments found at NS&T Mussel Watch Project sites located in or near the Reserves in relation to the concentrations found at NS&T sites nationwide. O'Connor (1996) calculated "high" concentrations (the mean plus one standard deviation of the geometric concentrations for all Mussel Watch sites) for the NS&T data. These calculated "high" concentrations include the highest 15% of the values for each chemical and thus are not indicative of problematic levels of contamination but

rather serve as a basis for categorizing the NS&T site data. The solid horizontal line [—] indicates the NS&T national geometric mean concentration for that chemical; the dashed horizontal line [---] indicates NS&T calculated "high" concentrations.

☛ It has been demonstrated that oysters and mussels are not equal in their ability to concentrate chemicals (O'Connor, 1992). While there is no statistically significant differences found between their organic contaminant accumulating abilities, it was found that oysters have a greater affinity for silver, copper, and zinc, while mussels were found to have a greater affinity for chromium and lead. In this report, the NS&T mussel and oyster data for these elements

National Estuarine Research Reserve	NS&T Site Code	General Location	Specific Location	Years Sampled	Location	
					Latitude (N)	Longitude (W)
Wells, ME	CAKP	Cape Arundel	Kennebunkport	5	43° 20.86	70° 28.48
Waquoit Bay, MA	BBNI	Buzzards Bay	Naushon Island	3	41° 30.76	70° 44.48
Narragansett Bay, RI	NBPI	Narragansett Bay	Patience Island	5	41° 39.36	71° 21.13
Delaware, DE	DBHC	Delaware Bay	Hope Creek	1	39° 25.6	75° 29.6
Chesapeake Bay, VA	CBDP	Chesapeake Bay	Dandy Point	8	37° 06.03	76° 17.73
North Carolina, NC	BIPI	Beaufort Inlet	Pivers Island	4	34° 43.1	76° 40.53
	CFBI	Cape Fear	Battery Island	8	33° 54.91	78° 00.5
North Inlet-Winyah Bay, SC	WBLB	Winyah Bay	Lower Bay	5	33° 14.6	79° 11.78
Sapelo Island, GA	SSSI	Sapelo Sound	Sapelo Island	7	31° 23.2	81° 17.33
Jobos Bay, Puerto Rico	PRBJ	Puerto Rico	Bahia De Jobos	2	17° 56.33	66° 10.95
Rookery Bay, FL	RBHC	Rookery Bay	Henderson Creek	8	26° 01.5	81° 44.2
Apalachicola Bay, FL	APDB	Apalachicola Bay	Dry Bar	8	29° 40.45	85° 04.4
	APCP	Apalachicola Bay	Cat Point Bar	8	29° 43.45	84° 53.05
Tijuana River, CA	IBNJ	Imperial Beach	North Jetty	8	32° 35.25	117° 07.95
Elkhorn Slough, CA	MBML	Monterey Bay	Moss Landing	4	36° 48.08	121° 47.35
South Slough, OR	CBCH	Coos Bay	Coos Head	8	43° 21.03	124° 19.85

Table 2. Reserves with NS&T sites located within or near.

have been analyzed separately. References made to NS&T bivalve data include combined mussel and oyster data.

☛ The sediment data have been adjusted so that data from samples containing more than 80% sand-sized particles [greater than 63 microns (μ)] were not used in comparisons among sites. Values for sediment samples containing less than 80% sand have been adjusted by dividing the contaminant concentrations by the fractions of the sediment that were fine-grained (i.e., dividing by numbers between 0.20 and 1.00). For organics in sediments, concentrations at the NS&T Coos Bay site near the South Slough NERR were below detectable limits.

☛ Of the organic compounds described in Table 1 and used for this report, total chlordane and total DDT are chlorinated pesticides. Total chlordane (tCdane) is the sum of the concentrations of four compounds: alpha-chlordane + trans-nonachlor + heptachlor + heptachlor-epoxide; total DDT (tDDT) is the sum of concentrations of ortho and para forms of parent DDT and its metabolites, i.e., opDDE + ppDDE + opDDD + ppDDD + opDDT + ppDDT. For this report, all PAH compounds measured by the program (Table 1) have been combined into a single group and designated as tPAH. All the measured polychlorinated biphenyls have been combined as tPCB.

Discussion

Appendices A and B summarize the results of the Mussel Watch Project bivalve data and NS&T Program sediment data presented in this paper. The [☆] symbol indicates values which exceed the NS&T national mean; the [★★] symbol indicates values exceeding the NS&T calculated "high" concentration.

Previous reports describing NS&T data have shown two major findings: first, that for the most part, high levels of contamination are restricted to a few areas near major industrialized urban centers (Robertson et al., 1993; Daskalakis and O'Connor, 1995); and secondly, for most contaminants at most sites trends in concentrations over the past 10 years are not detected. However, where trends are detected, these are more commonly decreasing than increasing (O'Connor and Beliaeff, 1995).

References

Cantillo, A. Y. and G. G. Lauenstein. 1993. Performance based quality assurance of the NOAA National Status and Trends Program. In: Parkany M, (ed) Quality Assurance for Analytical Laboratories. Royal Society of Chemistry, Cambridge, UK pp 34-43.

Daskalakis, K.D. and T.P. O'Connor. 1995. Normalization and elemental sediment contamination in the coastal U.S. *Environ. Sci. Technol.* 29(2): 470-7.

Lauenstein, G. G. and A. Y. Cantillo (eds). 1993. Sampling and analytical methods of the NOAA National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 184-1992: Vol. I-IV. Tech memo NOS ORCA 71. NOAA/NOS/ORCA, Silver Spring, MD.

Nriagu, J. O. 1989. A global assessment of natural sources of atmospheric trace elements. *Nature*, 338, 47-9.

O'Connor, T. P. 1992. *Mussel Watch: Recent Trends in Coastal Environmental Quality*. NOAA Rockville, MD, 46 pp.

O'Connor, T. P. 1996. Trends in Chemical Concentrations in Mussels and Oysters Collected Along the US Coast from 1986 to 1993. *Marine Environmental Research*, Vol. 41, No. 2, pp. 183-200.

O'Connor, T.P. and B. Beliaeff. 1995. Recent Trends in Coastal Environmental Quality: Results from the Mussel Watch Project. NOAA Silver Spring, MD. 40 pp.

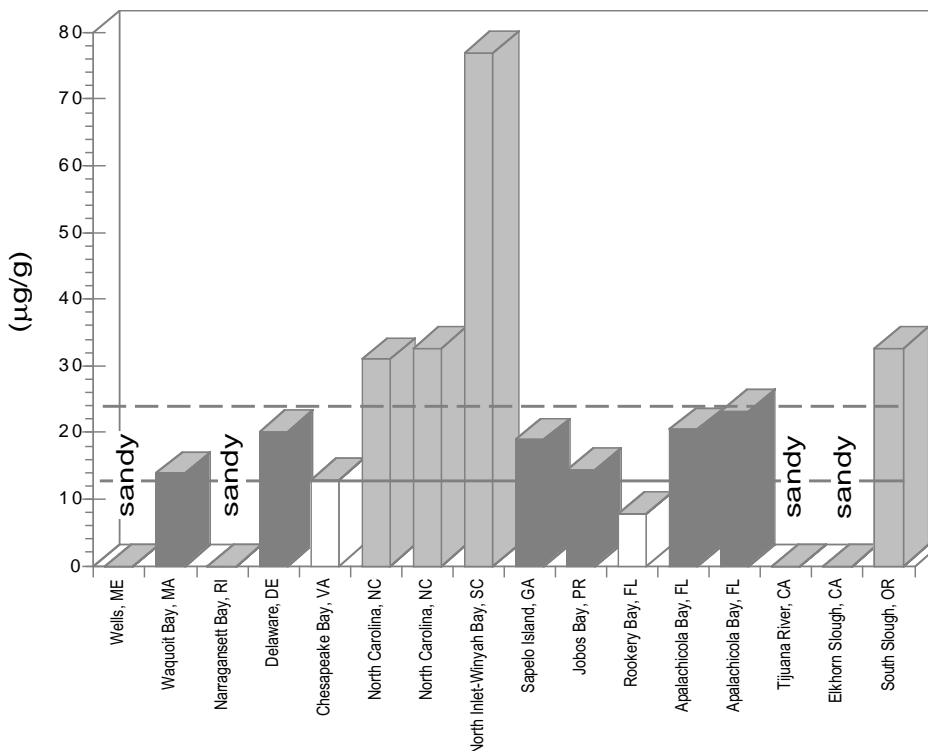
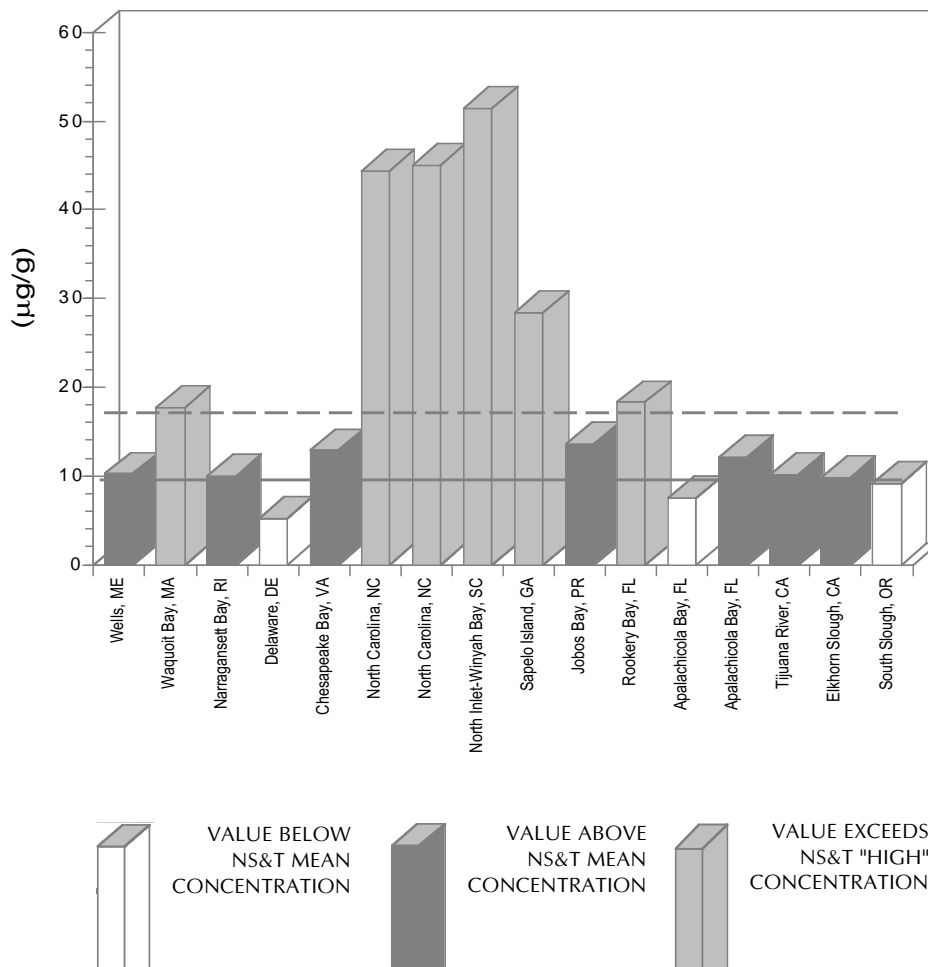
Robertson, A., C.A. Parker, and J. Price. 1993. National Status and Trends Program: National overview of trace metal concentrations in coastal surficial sediments. pp. 363-372. *Proceedings of the Twelfth International Conference of the Coastal Society*. The Coastal Soc., Gloucester, MA. 918 pp.

Further Reading

Lauenstein, G. G., Harmon, M. F. & Gottholm, B. W. 1993. National Status and Trends Program: Monitoring Site Descriptions (1984-1990) for the National Mussel Watch and Benthic Surveillance Projects. NOAA Technical Memorandum NOS ORCA 70 Silver Spring, MD.

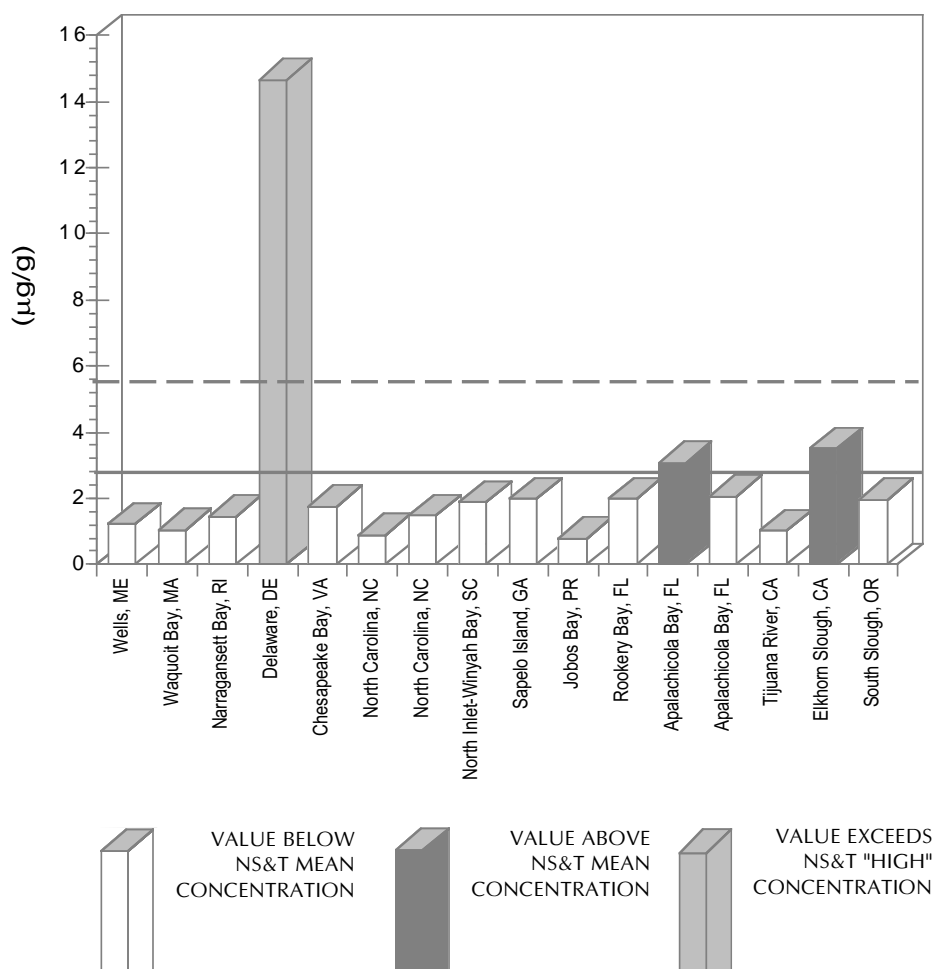
O'Connor, T.P. 1994. The National Oceanic and Atmospheric Administration (NOAA) National Status and Trends Mussel Watch Program: National Monitoring of Chemical Contamination in the Coastal United States. In: C.R. Cothorn & N.P. Ross (eds) *Environmental Statistics, Assessment and Forecasting*. Lewis Publishers, Boca Raton, FL, pp. 331-9.

O'Connor, T. P., Cantillo, A. Y. & Lauenstein, G. G. 1994. Monitoring of Temporal Trends in Chemical Contamination by the NOAA National Status and Trends Mussel Watch Project. In: K. J. M. Kramer (ed.) *Biomonitoring of Coastal Waters and Estuaries*. Crc Press, Boca Raton, FL, pp. 29-50.



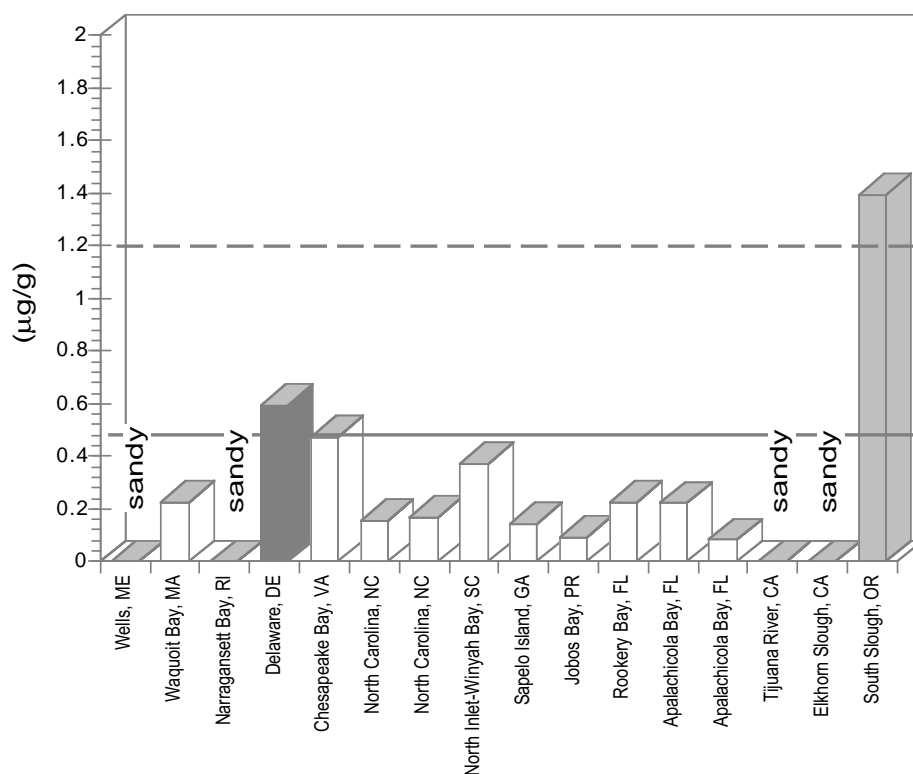
Cd (bivalves)

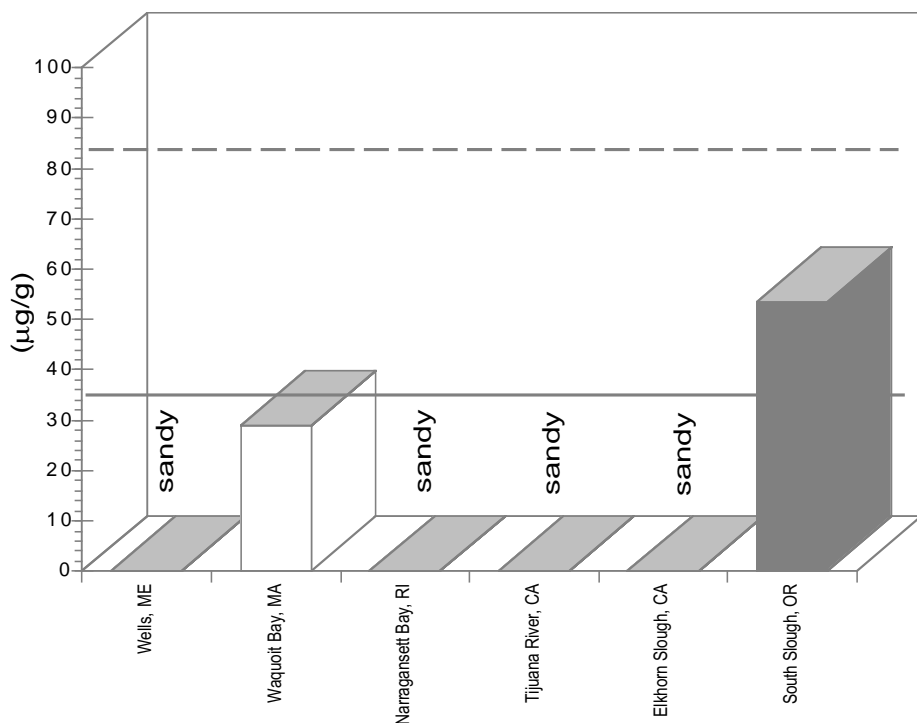
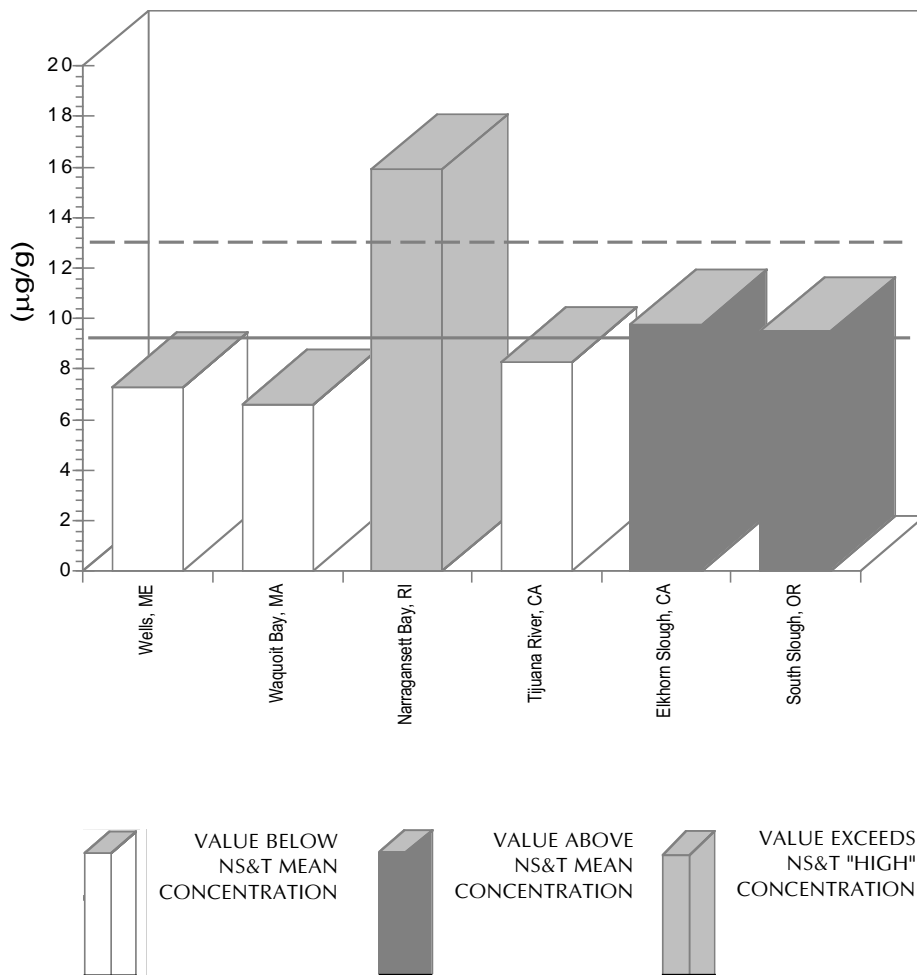
The Mussel Watch site near the Blackbird Creek component of the Delaware NERR has the second highest mean concentration for cadmium (15 ppm) of all Mussel Watch bivalve sites in the U.S.; two other sites, the ones in the Apalachicola Bay NERR and the Elkhorn Slough NERR, are above the Mussel Watch national mean; the remaining sites are below the national mean with the site in the Jobos Bay NERR in Puerto Rico having a mean low concentration of 0.7 ppm.



Cd (sediment)

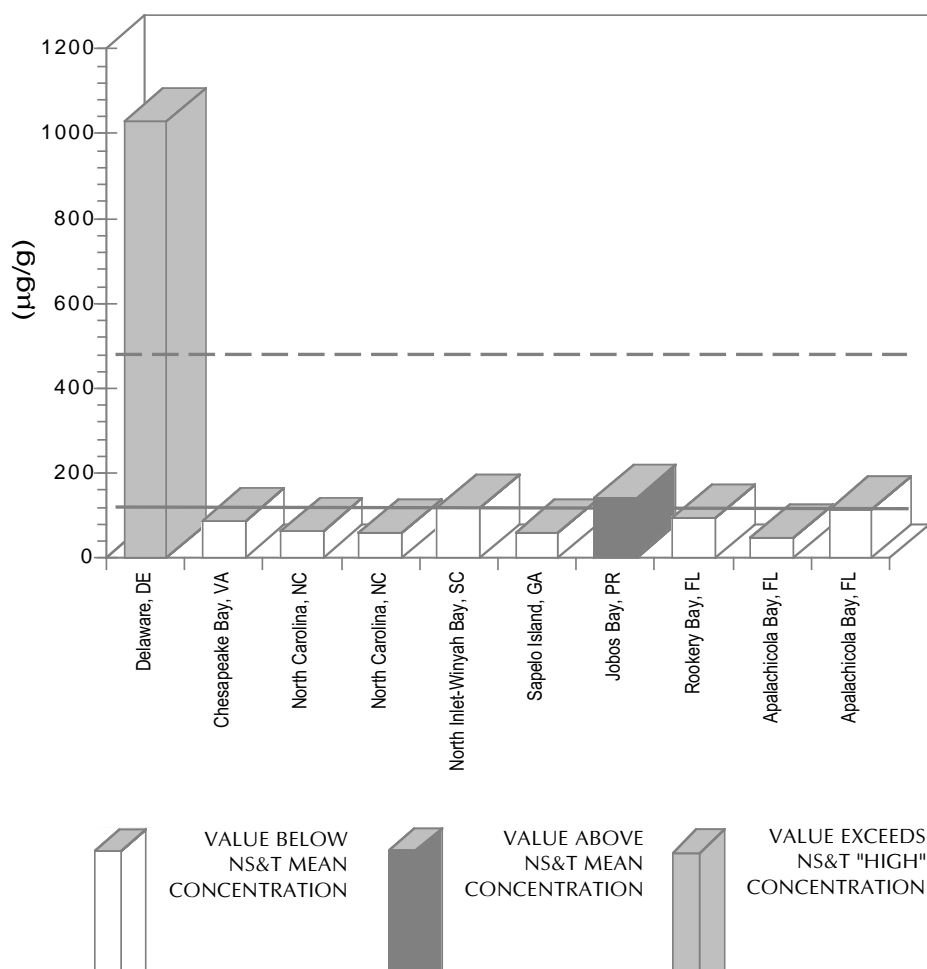
Mean concentrations for cadmium range from a low of 0.08 ppm at the Cat Point Bar site at the Apalachicola Bay NERR to a high of 1.39 ppm near the South Slough NERR. Except for the Blackbird Creek component of the Delaware NERR, the remaining sites fall below the national mean.





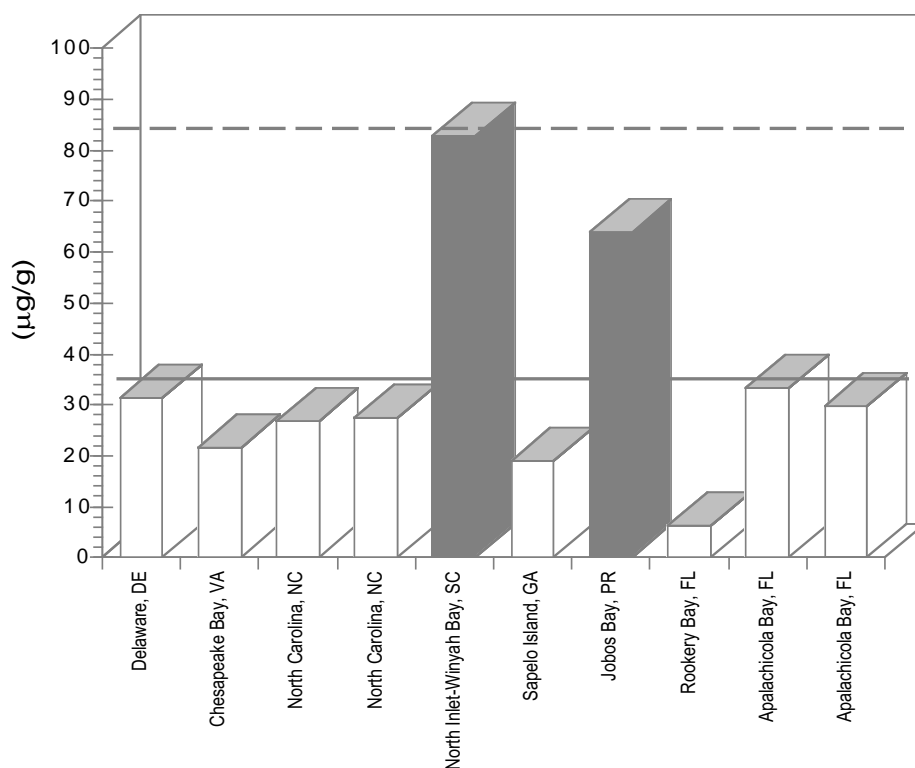
Cu (oysters)

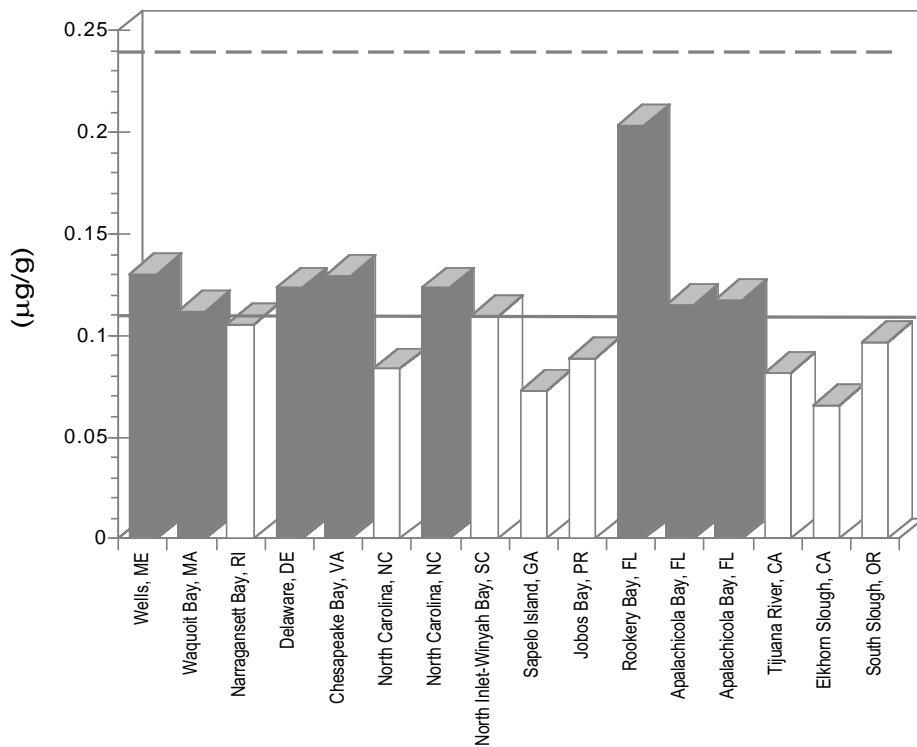
The site near the Blackbird Creek component of the Delaware NERR has the fourth highest concentration of copper of all Mussel Watch oyster sites nationwide; only one other site, in the Jobos Bay NERR in Puerto Rico, is above the national mean.



Cu (sediment)

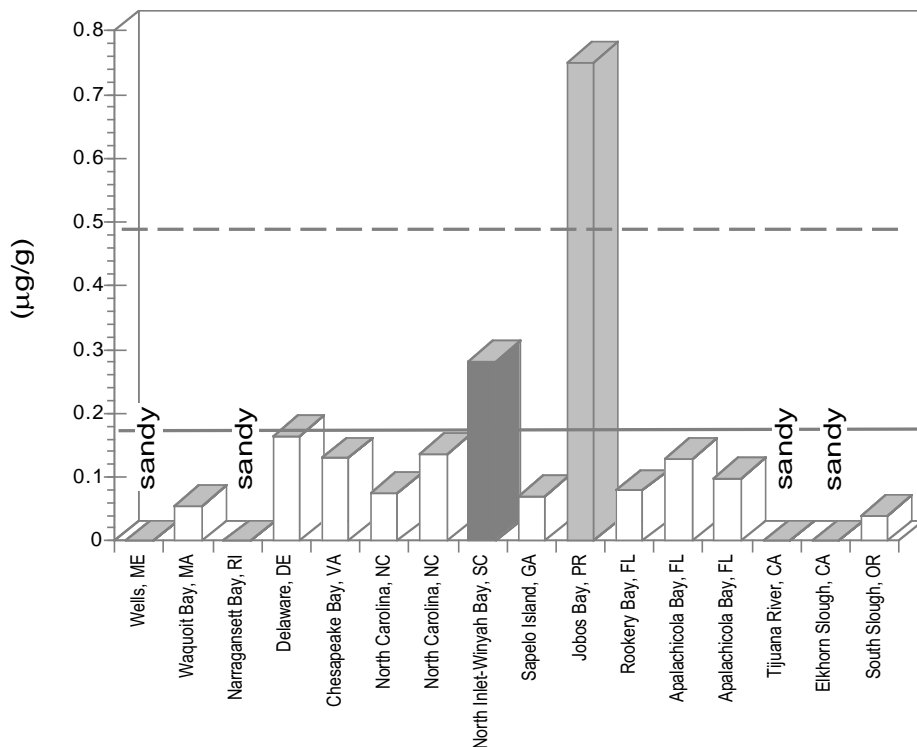
Mean copper concentrations found in sediments collected at Mussel Watch oyster sites ranges from a low of 6.29 ppm near the Rookery Bay NERR to a high of 82.8 ppm near the North Inlet-Winyah Bay NERR, with no values exceeding the calculated national "high" level.





Hg (bivalves)

Mercury values range from a low of 0.06 ppm at the Mussel Watch site near the Elkhorn Slough NERR to a high of 0.2 ppm at the site near the Rookery Bay NERR. No NERRS have values in the "high" range.

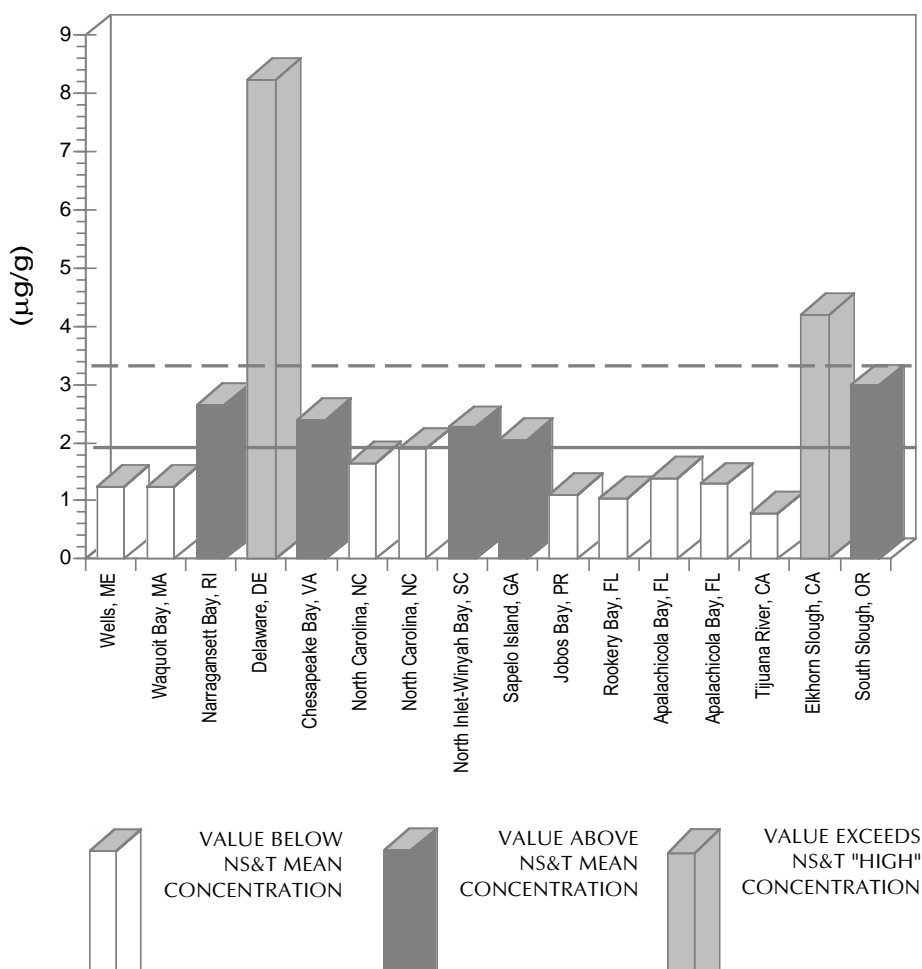


Hg (sediment)

Mean concentration values for mercury in sediment at the NERRS ranges from a low of 0.04 ppm at the Coos Bay Mussel Watch site near the South Slough NERR, to 0.75 ppm at the Mussel Watch site near the Jobos Bay NERR, which is above the 80th percentile for concentrations of mercury in sediment nationwide.

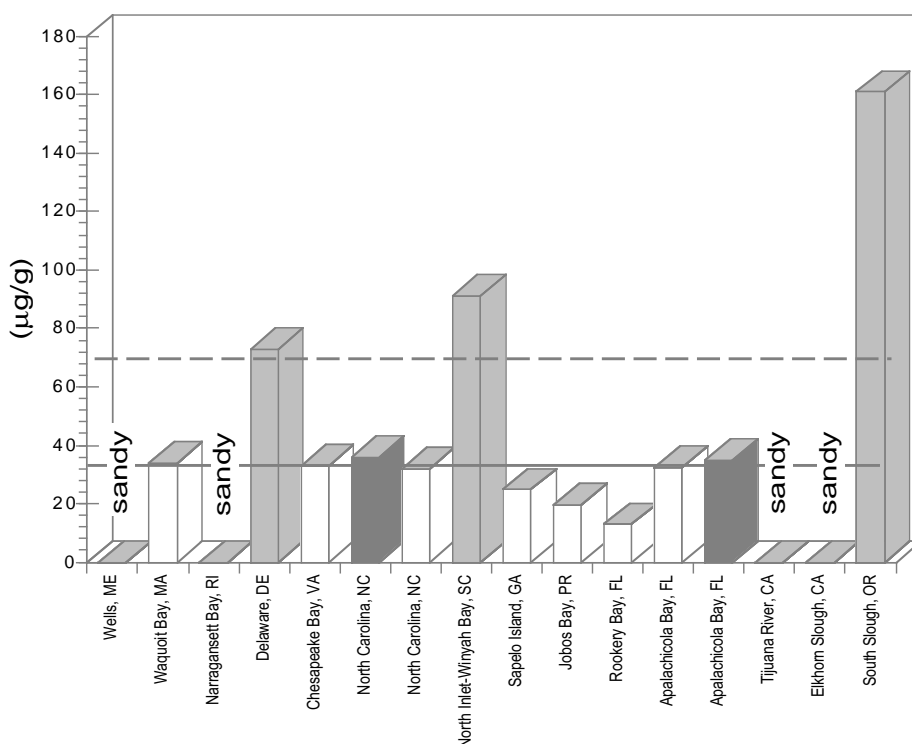
Ni (bivalves)

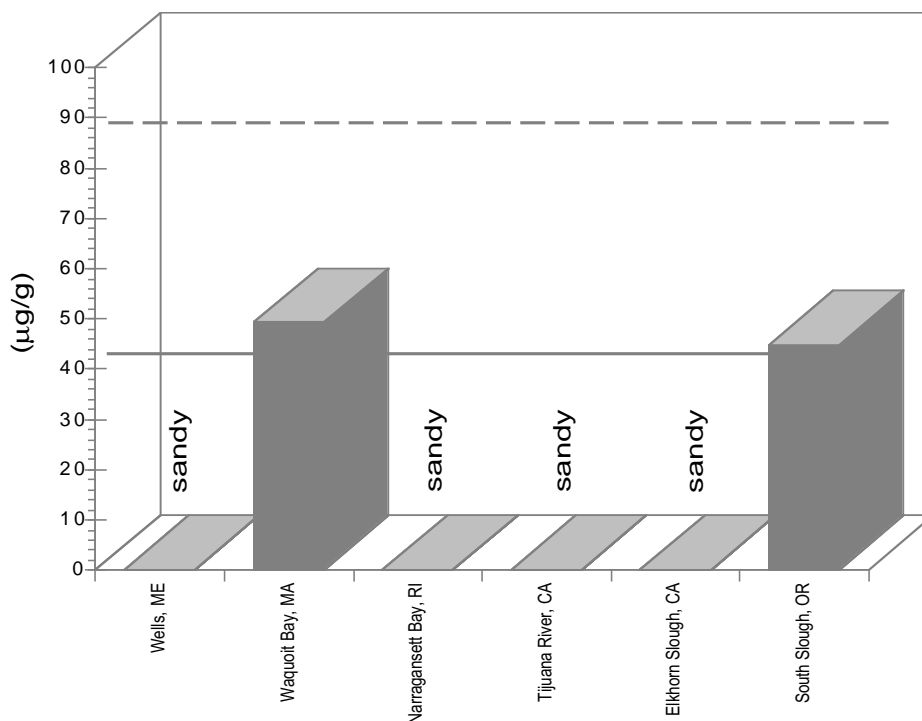
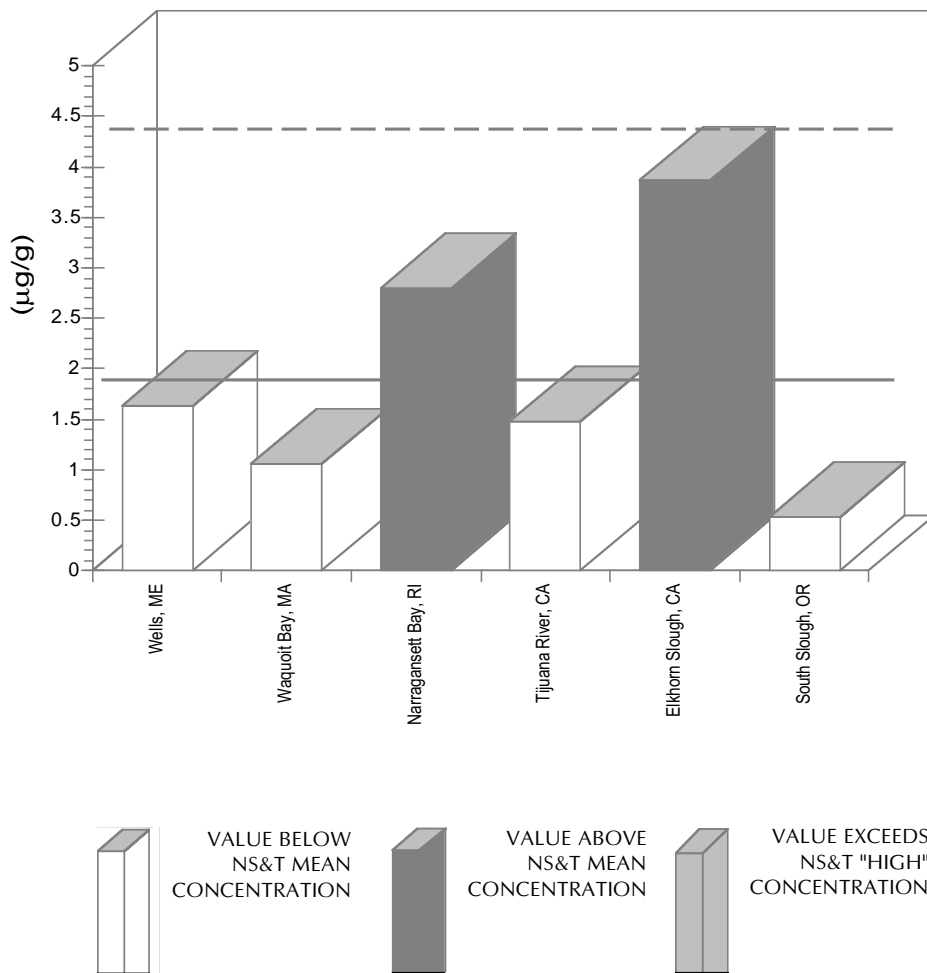
The Mussel Watch site near the Blackbird Creek component of the Delaware NERR has the fourth highest concentration of nickel of all Mussel Watch bivalve sites nationwide; one other site, that near the Elkhorn Slough NERR, is also above the NS&T calculated "high". The level at the Mussel Watch site near the Tijuana River NERR is among the lowest mean value for nickel of all sites.



Ni (sediment)

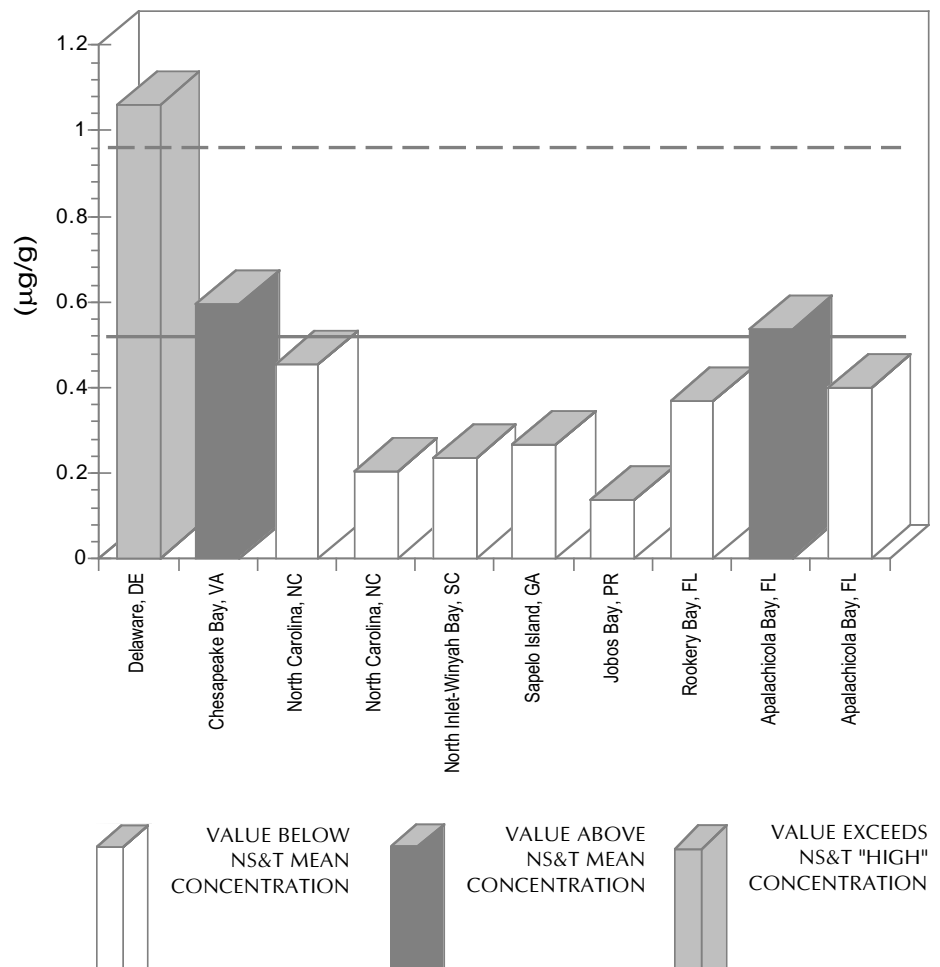
Three sites exceed the calculated NS&T "high" concentration (69 ppm) for nickel with the site in the South Slough NERR having a concentration of 161 ppm, which is in the upper 5% of all NS&T sediment data; two sites are above the mean concentration value for sediments, with four other sites having values just below the mean.





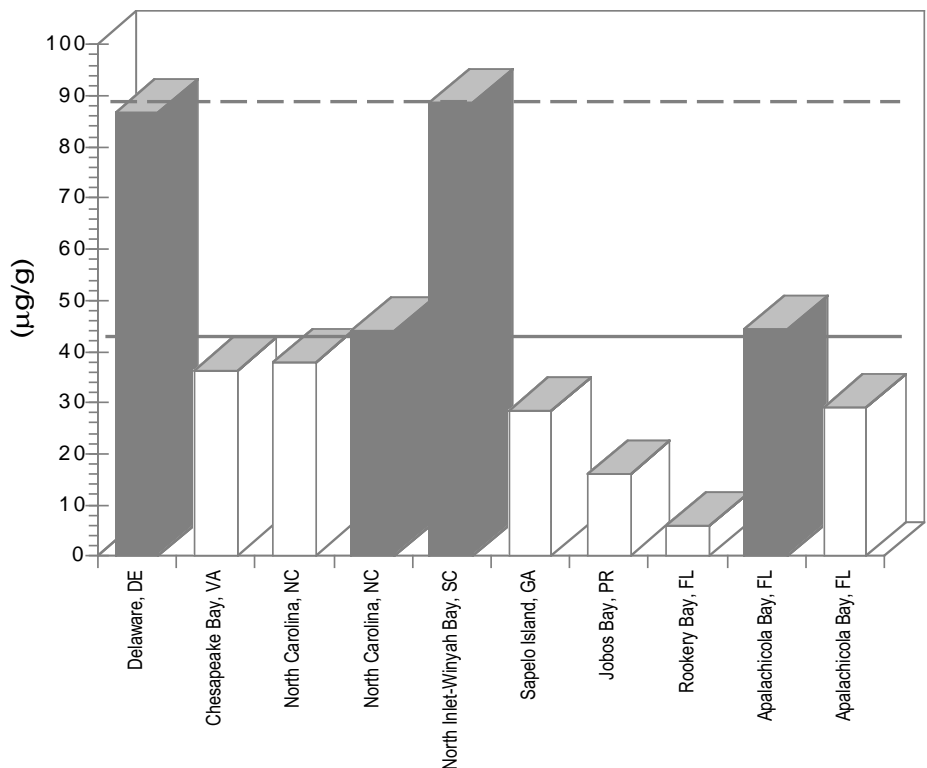
Pb (oysters)

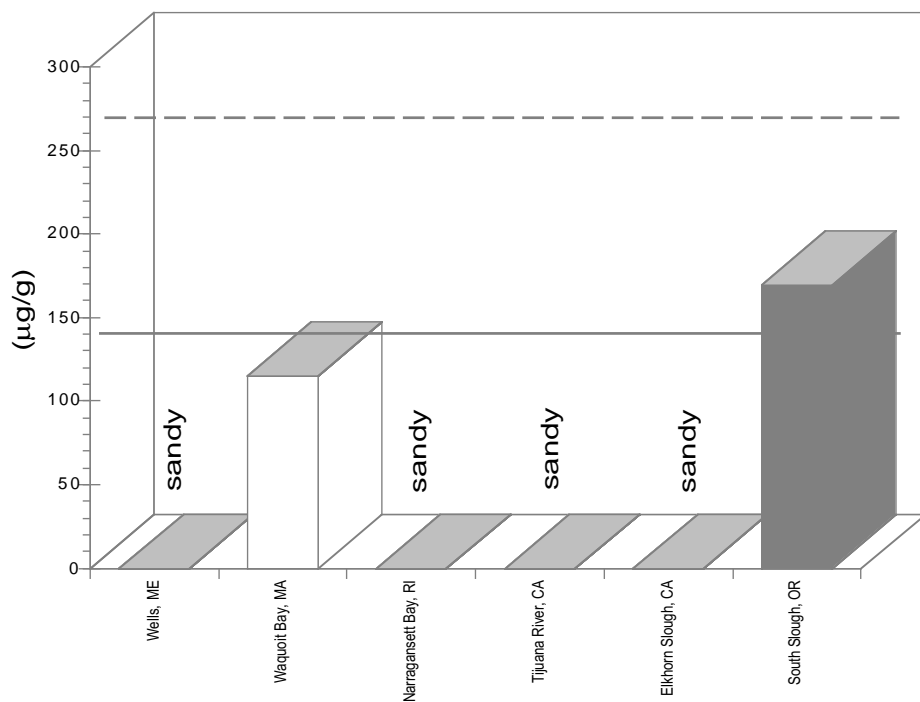
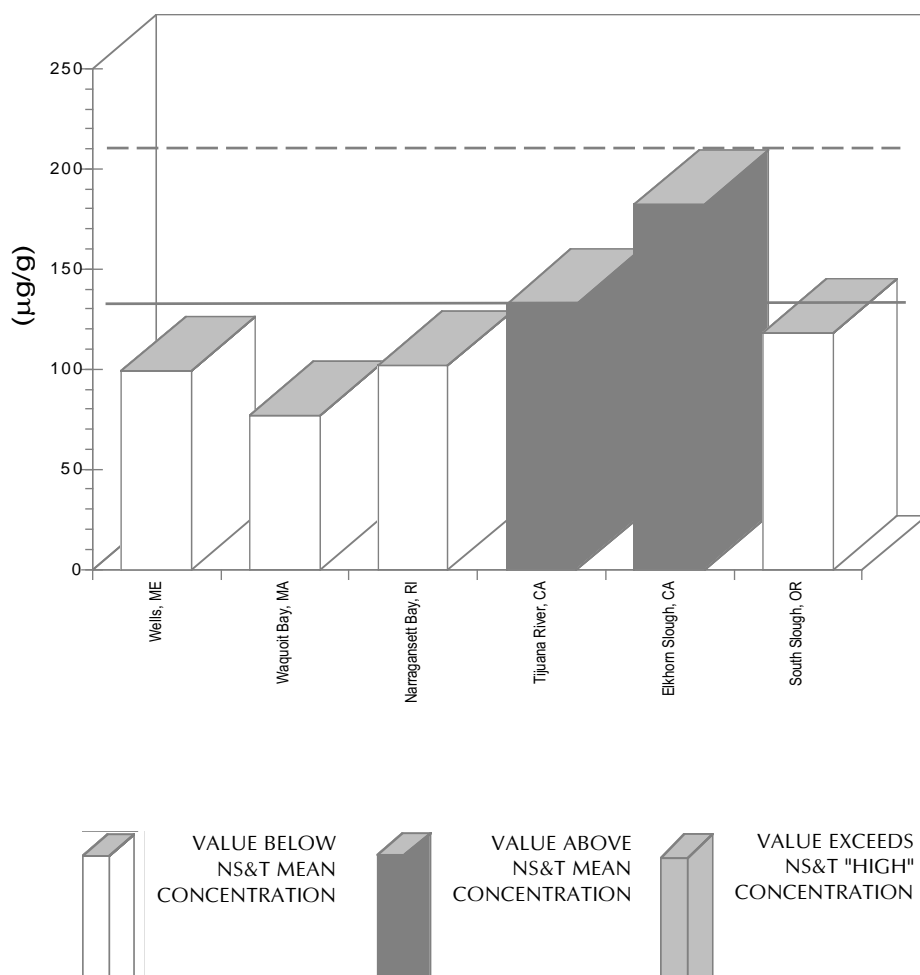
The mean concentration value for lead in oysters at the Mussel Watch site near the Blackbird Creek component of the Delaware NERR is above the 90th percentile for concentrations in oysters nationwide; two sites, one near the Chesapeake Bay NERR in Virginia and one near the Apalachicola Bay NERR, have values above the national mean concentration for oysters; the Mussel Watch site near the Jobos Bay NERR has the third lowest mean value for lead in oysters.



Pb (sediment)

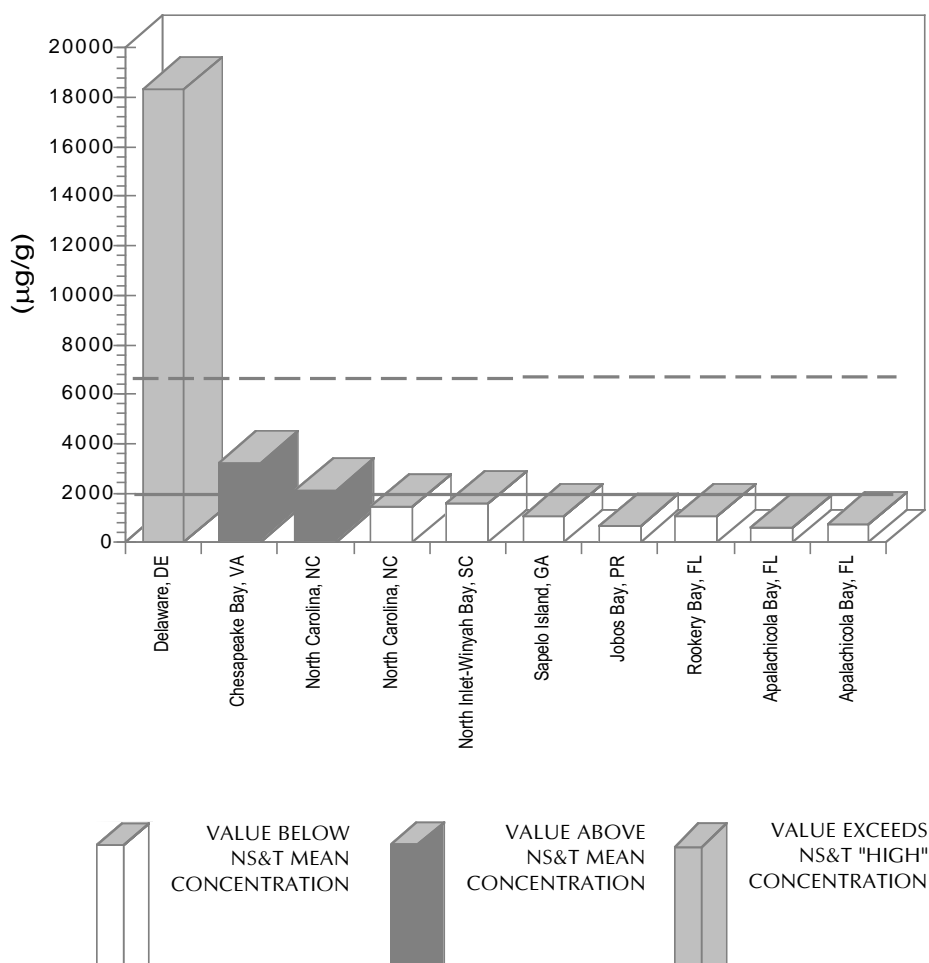
Mean concentration values for lead in sediments at the NS&T oyster sites range from a low of 5.8 ppm at the Rookery Bay NERR, the second lowest mean concentration value for all NS&T sediment data nationwide, to a high of 88.7 ppm at the site near the North Inlet-Winyah Bay NERR. No NERR has values in the "high" range.





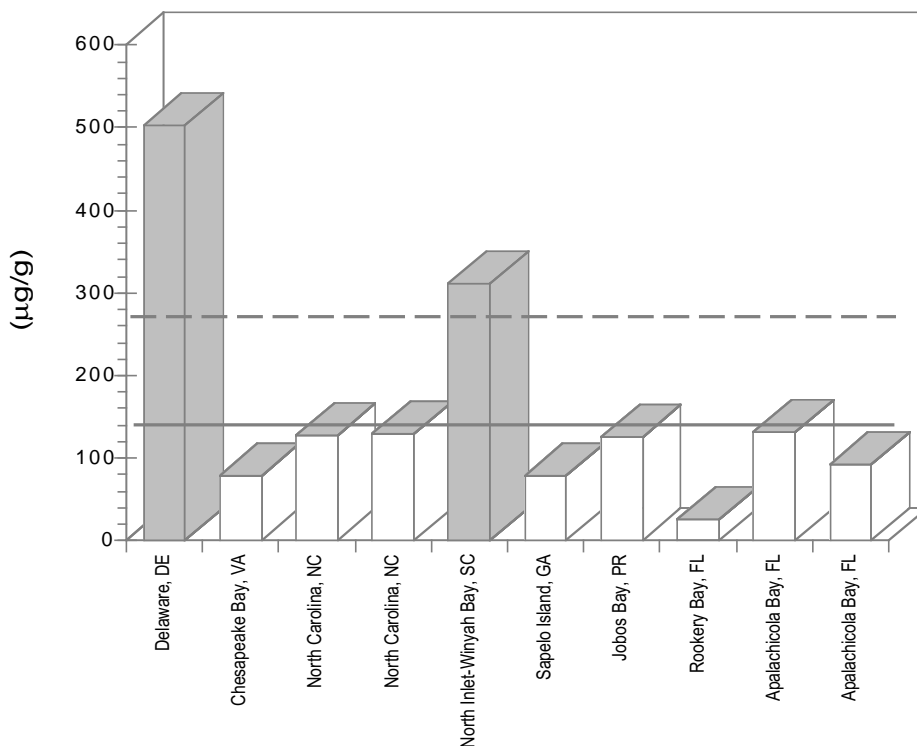
Zn (oysters)

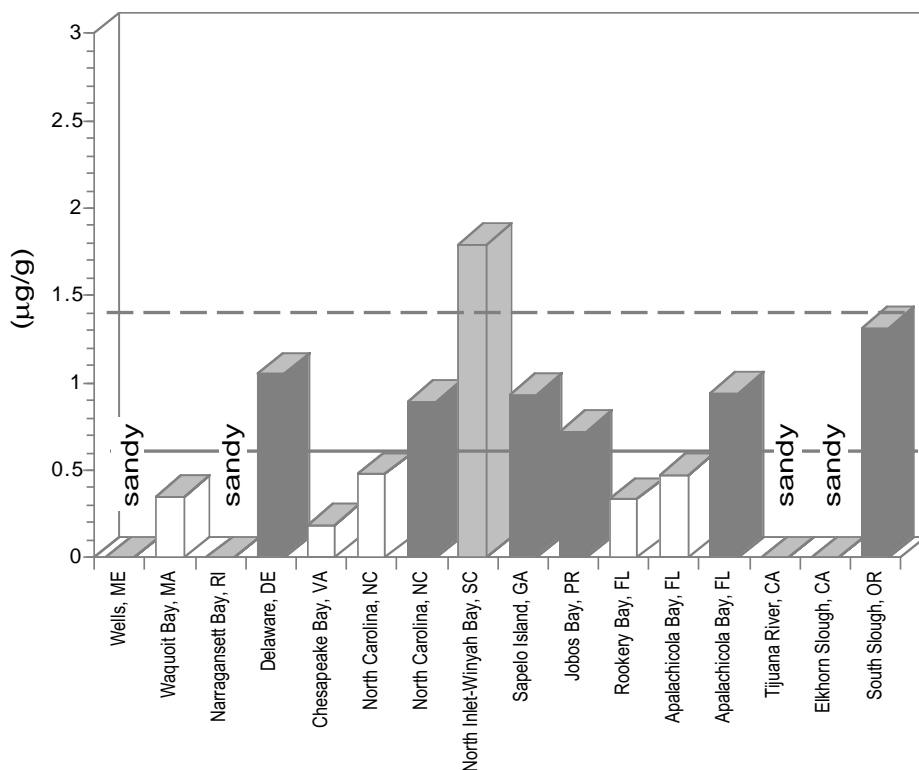
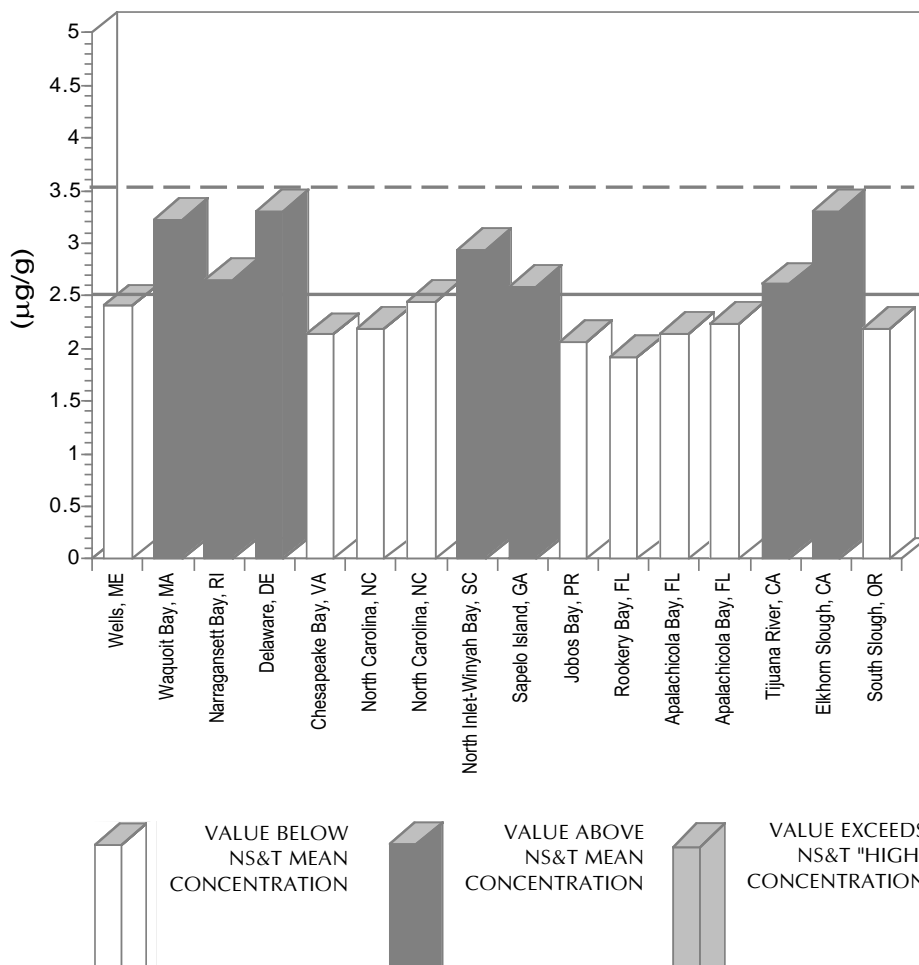
Concentrations of zinc in oysters ranges from 622 ppm at the Apalachicola Bay-Dry Bar Mussel Watch site, one of the two sites near the Apalachicola Bay NERR, to 18333 ppm near the Blackbird Creek component of the Delaware Bay NERR, the second highest mean concentration of zinc for oyster sites nationwide.



Zn (sediment)

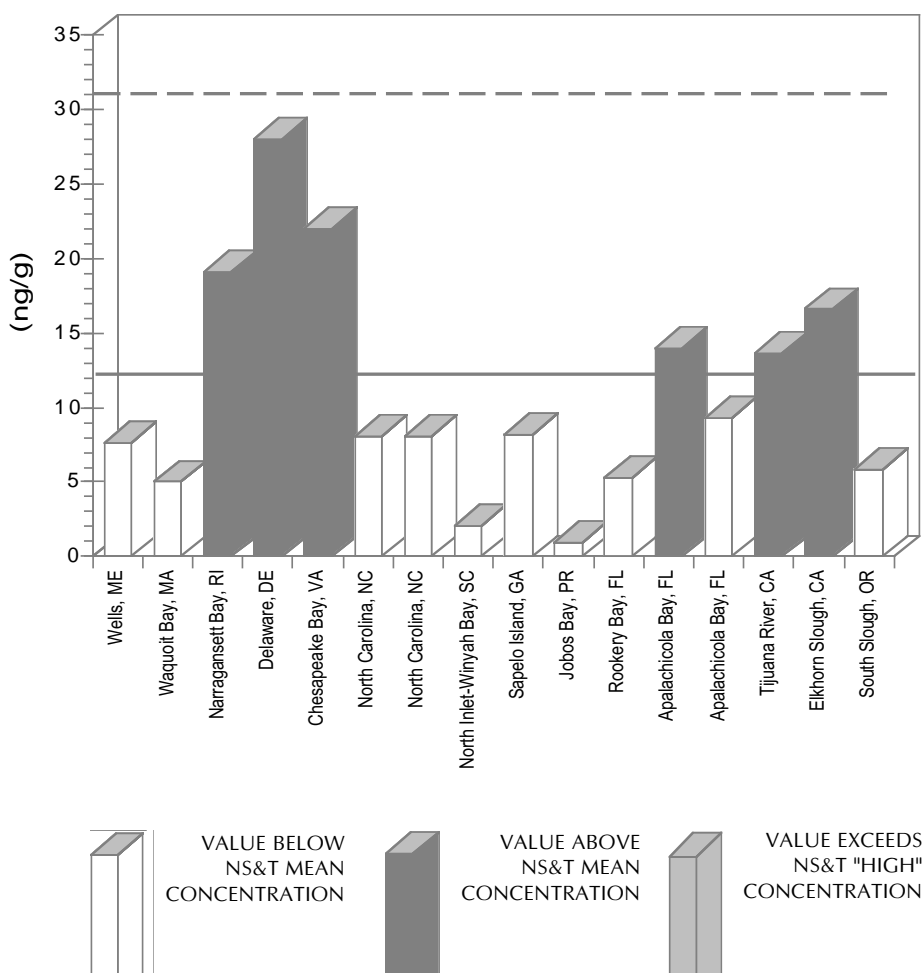
The Mussel Watch site near the Blackbird Creek component of the Delaware NERR is above the 95th percentile for concentrations of zinc in sediment nationwide; one other site, that near the North Inlet-Winyah Bay NERR, is also above the calculated NS&T "high". The mean concentration of zinc at the Rookery Bay NERR is the third lowest of all NS&T sediment concentrations.





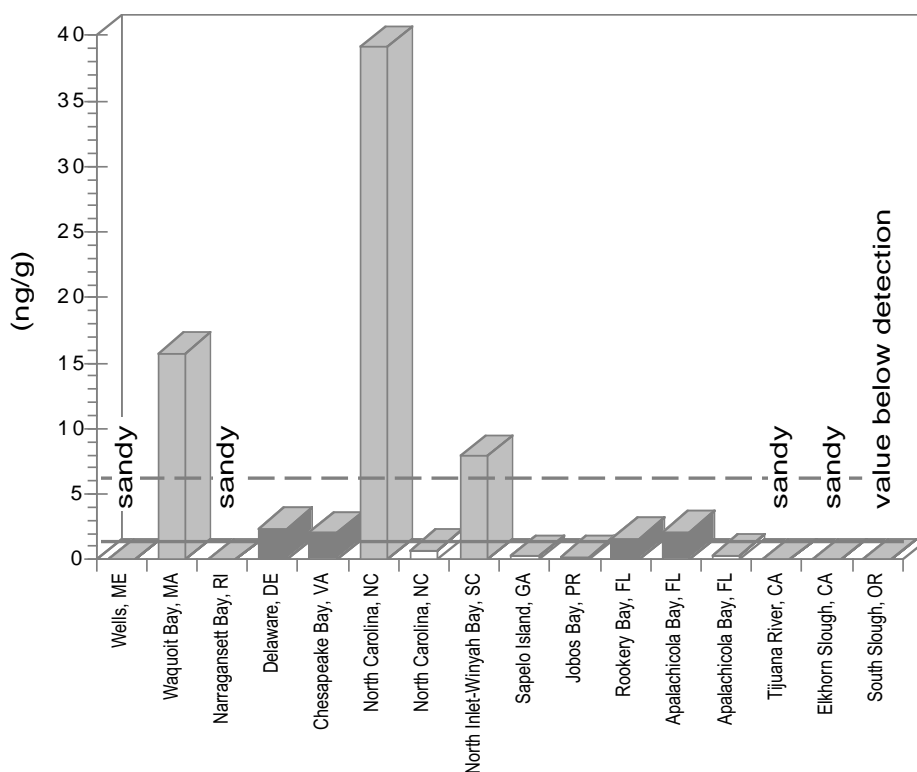
tCdane (bivalves)

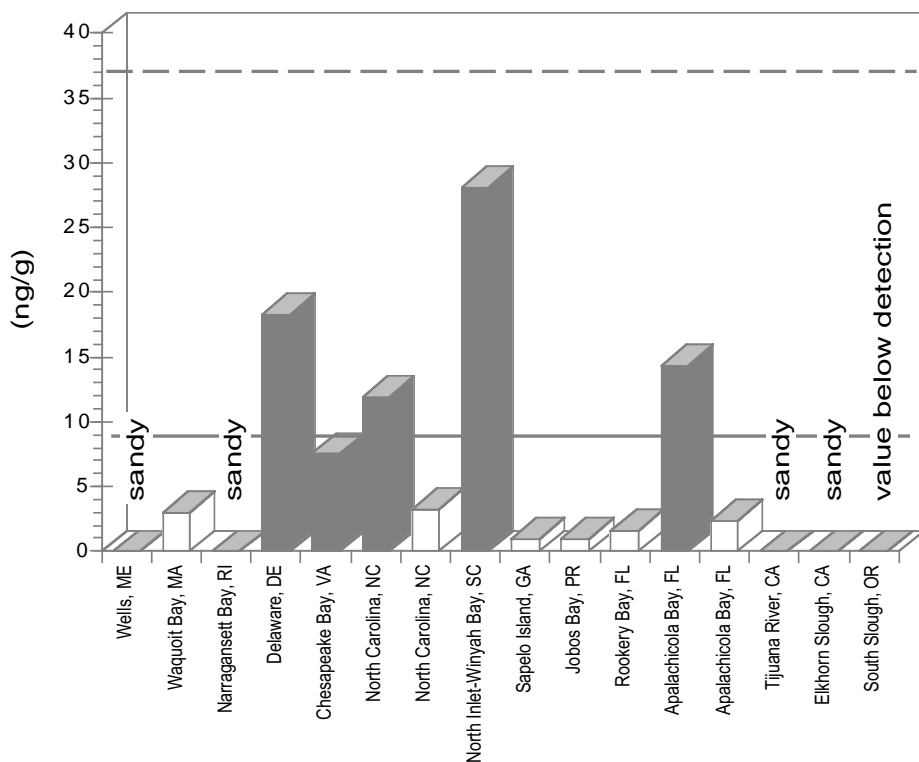
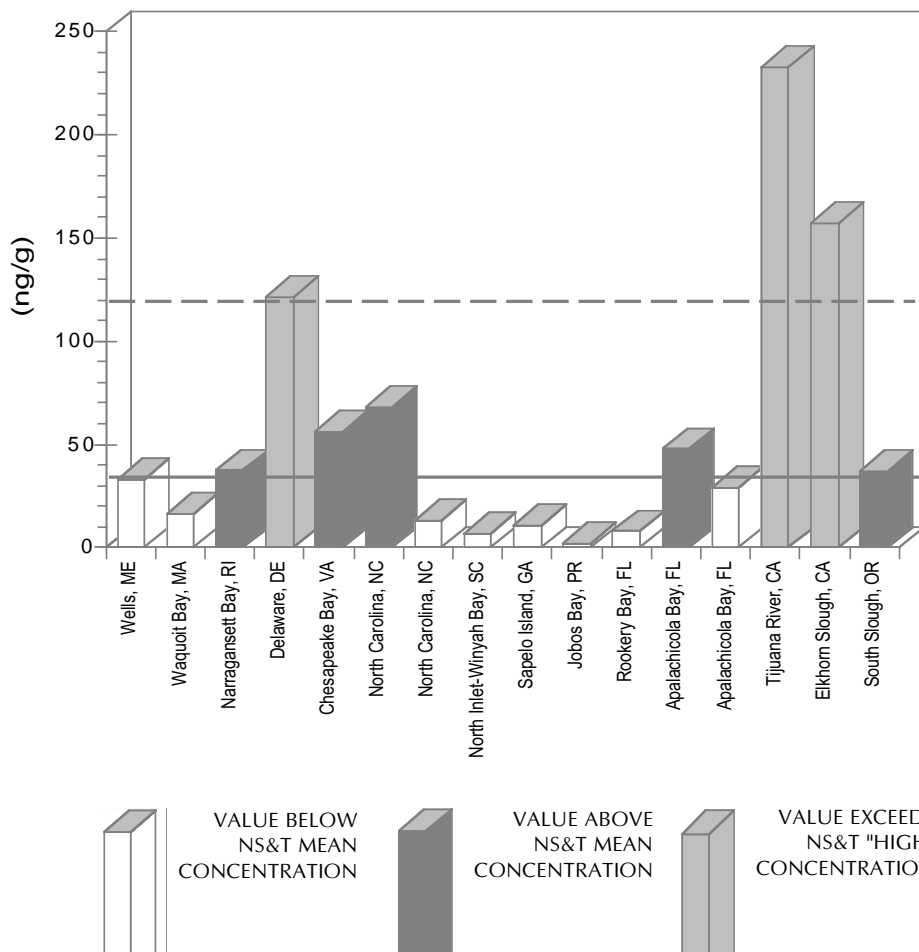
Six of the Mussel Watch sites have levels of total chlordanes above the national mean concentration. Concentrations range from a low of 0.9 ppm at the Mussel Watch site near the Jobos Bay NERR to 28 ppm near the Blackbird Creek component of the Delaware NERR. No Mussel Watch site in or near a NERR has a "high" value.



tCdane (sediment)

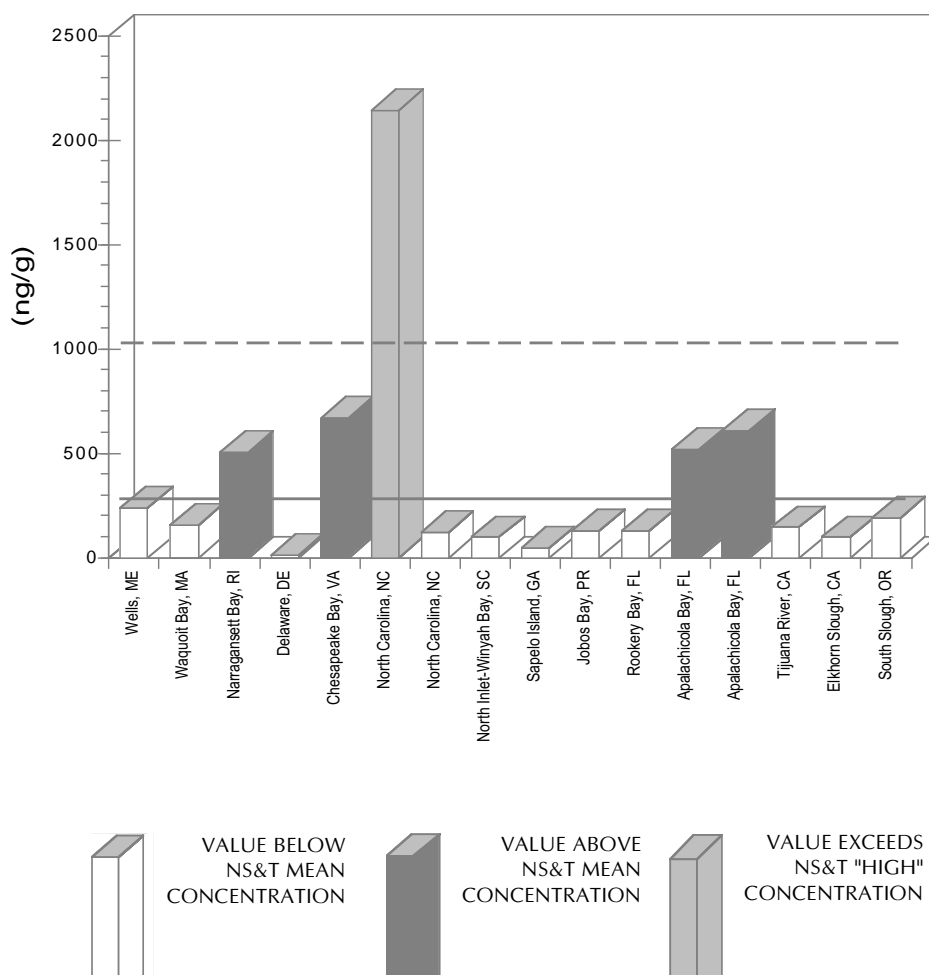
tCdane levels range from a low of 0.25 ppm at the site near the Sapelo Island NERR while three sites are above the calculated "high" concentration for tCdane in sediment with the Pivers Island NS&T site near the Rachel Carson component of the North Carolina NERR having a mean concentration in the upper 2% of all sediment nationwide.





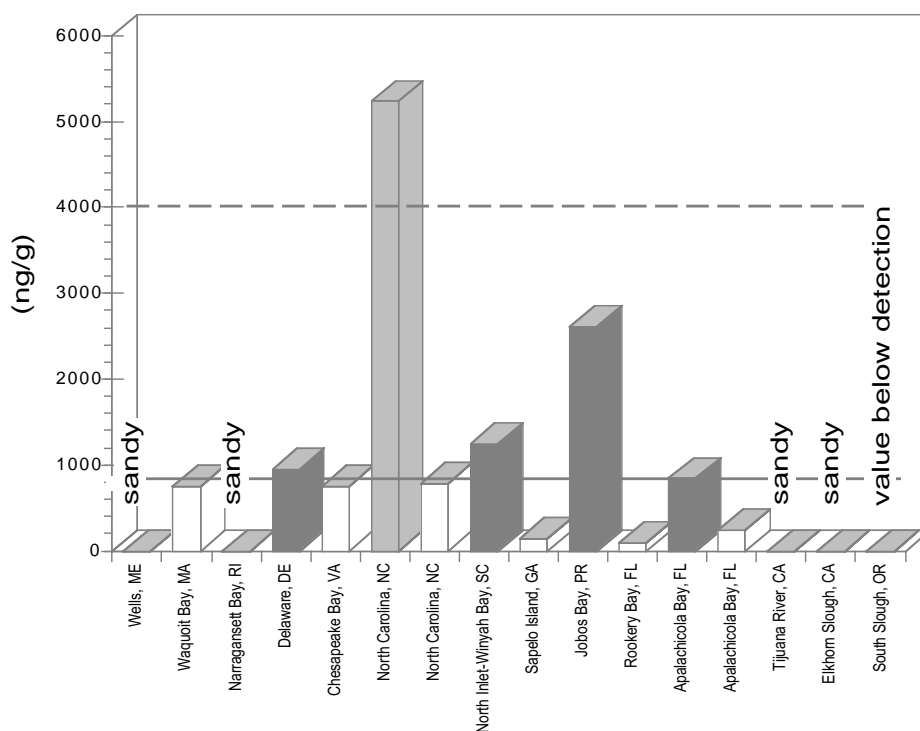
tPAH (bivalves)

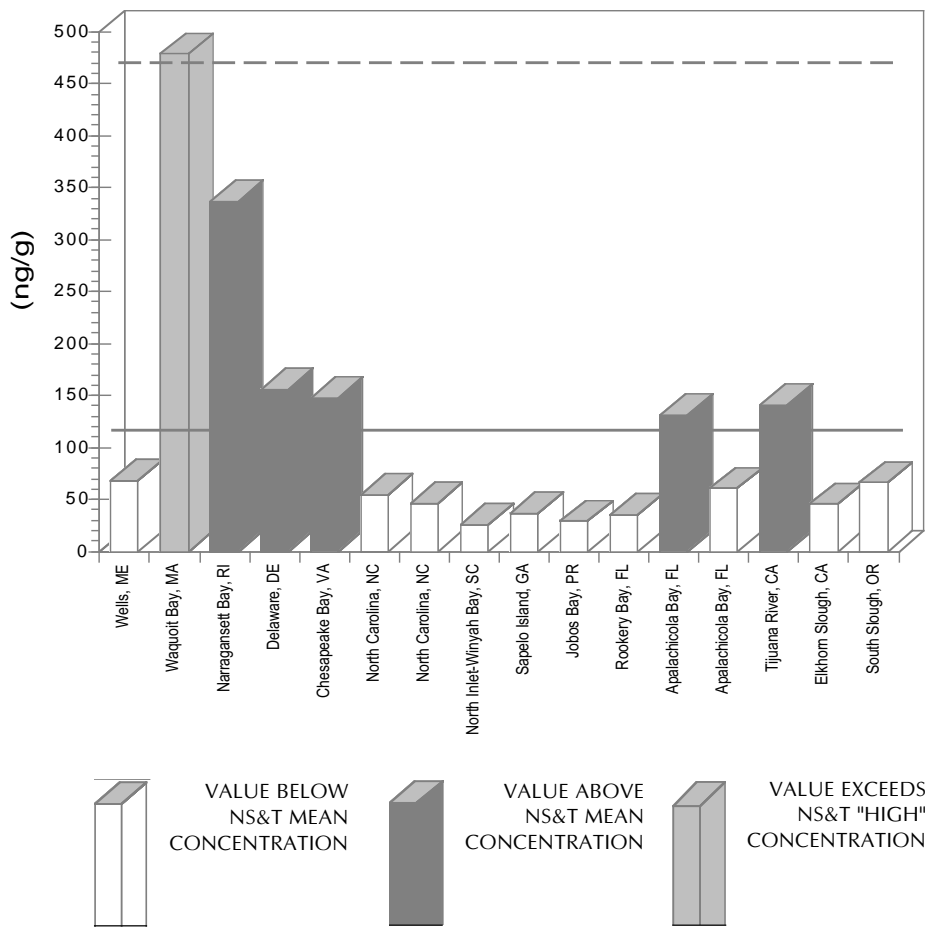
Mean concentrations for total polycyclic aromatic hydrocarbons range from a low of 13.5 ppm near the Blackbird Creek component of the Delaware NERR to a high of 2142 ppm near the Rachel Carson component of the North Carolina NERR. This value is in the upper 10% of all bivalves nationwide.



tPAH (sediment)

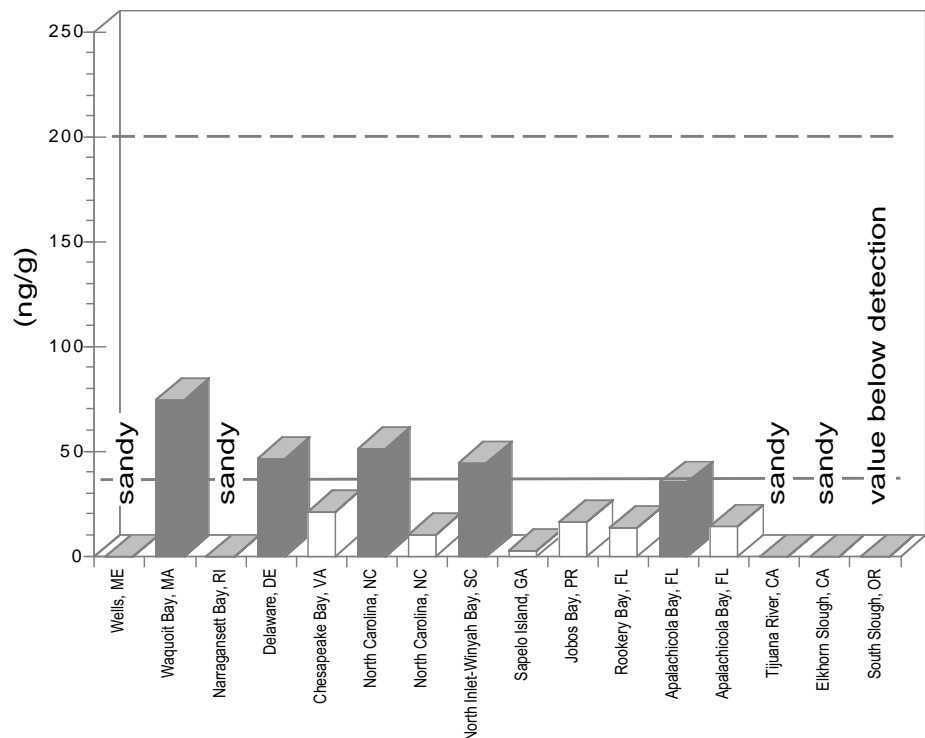
Mean concentrations for total polycyclic aromatic hydrocarbons in sediments range from 99.5 ng/g at the site near the Rookery Bay NERR to a high of 5232 ng/g near the Rachel Carson component of the North Carolina NERR; four sites are above the NS&T national mean; the remaining sites are below the mean.





tPCB (bivalves)

Total polychlorinated biphenyl PCB values range from a low of 26 ppm at the Mussel Watch site near the North Inlet/Winyah Bay NERR to 478 ppm at the Mussel Watch site near the Waquoit Bay NERR. This value is within the Mussel Watch calculated "high" concentration for tPCBs.



tPCB (sediment)

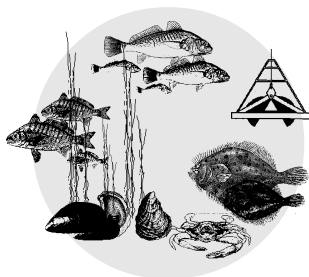
No total polychlorinated biphenyl PCB sediment values from NS&T NERR sites are above the calculated "high" concentration; five sites have values above the national mean; the remaining sites are below the mean with site near the Sapelo Island NERR having one of the lowest concentrations (2.6 ng/g) of all sediment values nationwide.

For more information on the National Status and Trends Program contact:
Coastal Monitoring and Bioeffects Assessment Division

NOAA/NOS
N/ORCA2, SSMC4
1305 East-West Highway
Silver Spring, MD 20910-3281
(301) 713-3028

To access National Status and Trends
Program information or data via the internet use:

<http://seaserver.nos.noaa.gov/projects/nsandt/nsandt.html>



For more information about the National Estuarine Research Reserves contact:
Sanctuaries and Reserves Division

NOAA/NOS
N/ORM2, SSMC4
1305 East-West Highway
Silver Spring, MD 20910-3281
(301) 713-3125

To access information about NOAA's
National Estuarine Research Reserves via the internet use:

<http://www.nos.noaa.gov/ocrm/srd/nerrs>

- Appendix A. NS&T sites with bivalve concentration values above the mean or calculated "high"
- Appendix B. NS&T sites with sediment concentration values above the mean or calculated "high"

Appendix A - NS&T sites with bivalve concentration values above the mean or calculated "high"

Reserves with NS&T site(s) having bivalve concentrations above the mean [☆] and/or NS&T calculated "high" [★★].

RESERVE and NS&T SITE	As	Cd	Cu	Hg	Ni	Pb	Se	Zn	tCdane	tDDT	tPAH	tPCB
Wells, ME												
CAKP	☆			☆								
Waquoit Bay, MA												
BBNI	★★			☆			☆					★★
Narragansett Bay, RI												
NBPI	☆		★★		☆	☆	☆		☆	☆	☆	☆
Delaware, DE												
DBHC		★★	★★	☆	★★	★★	☆	★★	☆	★★		☆
Chesapeake Bay, VA												
CBDP	☆			☆	☆	☆		☆	☆	☆	☆	☆
North Carolina, NC												
BIPI	★★							☆		☆	★★	
CFBI	★★			☆								
North Inlet/Winyah Bay, SC												
WBLB	★★				☆		☆					
Sapelo Island, GA												
SSSI	★★				☆		☆					
Jobos Bay, PR												
PRBJ	☆		☆									
Rookery Bay, FL												
RBHC	★★			☆								
Apalachicola Bay, FL												
APDB		☆		☆		☆			☆	☆	☆	☆
APCP	☆			☆							☆	
Tijuana River, CA												
IBNJ	☆						☆	☆	☆	★★		☆
Elkhorn Slough, CA												
MBML	☆	☆	☆		★★	☆	☆	☆	☆	★★		
South Slough, OR												
CBCH			☆		☆					☆		

Appendix B - NS&T sites with sediment concentration values above the mean or calculated "high"

Reserves with NS&T site(s) having sediment concentrations above the mean [☆] and/or NS&T calculated "high" [★★].

RESERVE and NS&T SITE	As	Cd	Cu	Hg	Ni	Pb	Se	Zn	tCdane	tDDT	tPAH	tPCB
Wells, ME												
CAKP - sandy												
Waquoit Bay, MA												
BBNI	☆					☆			★★			☆
Narragansett Bay, RI												
NBPI - sandy												
Delaware, DE												
DBHC	☆	☆			★★	☆	☆	★★	☆	☆	☆	☆
Chesapeake Bay, VA												
CBDP									☆	☆		
North Carolina, NC												
BIPI	★★				☆				★★	☆	★★	☆
CFBI	★★					☆	☆					
North Inlet/Winyah Bay, SC												
WBLB	★★		☆	☆	★★	☆	★★	★★	★★	☆	☆	☆
Sapelo Island, GA												
SSSI	☆						☆				☆	
Jobos Bay, PR												
PRBJ	☆		☆	★★			☆					
Rookery Bay, FL												
RBHC									☆			
Apalachicola Bay, FL												
APDB	☆					☆	☆		☆	☆	☆	☆
APCP	☆				☆							
Tijuana River, CA												
IBNJ - sandy												
Elkhorn Slough, CA												
MBML - sandy												
South Slough, OR												
CBCH	★★	★★			★★	☆	☆	☆	below detection	below detection	below detection	below detection



July 1996